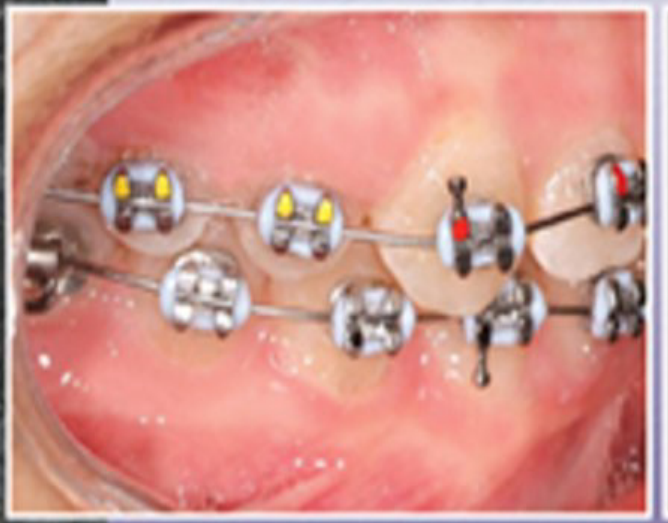
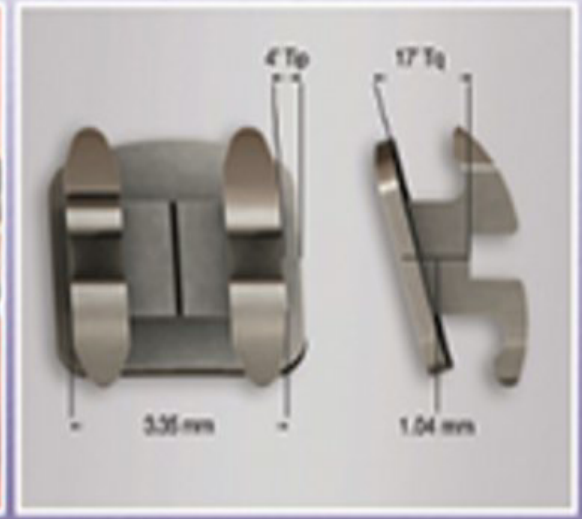
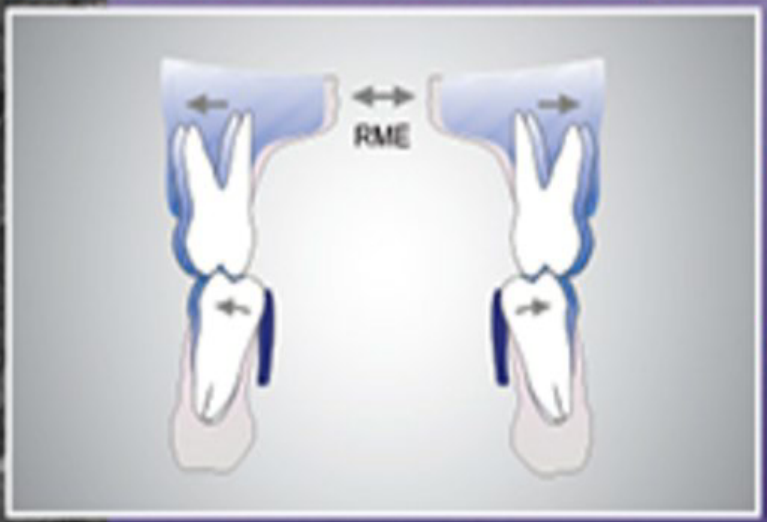
Fundamentals of Orthodontic Treatment Mechanics







John C. Bennett – Richard P. McLaughlin

Fundamentals of Orthodontic Treatment Mechanics

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Foreword

This book has been several years in preparation, and is the third part of a trilogy. It is slightly different in style and structure from our earlier works, so perhaps a word of explanation is in order.

We have spent the last three decades developing treatment mechanics, writing about the subject, and lecturing on it. In 2010 we felt it was time to bring it all together, and we started on a magnum opus of more than 370 pages. Soon it became clear it was not the approach we wanted.

Our treatment approach has been developed by a long process of evolution, with many options being tried along the way. It is now well defined, and looking at our earlier texts, it was hard to see a better or more concise way of presenting what has been written before. Instead, we felt another medium sized book was required, which would summarize our earlier work and at the same time bring everything up to date. Detail could be avoided in such a book, because sources could be given from earlier texts. Recent developments would be included, and topics which had not been fully explained previously, such as case settling and post-treatment management, could be given more attention.

We decided on a conventional printed book, although there were requests to produce this as a digital publication. Digital sources are useful for quick access to pieces of information, but the printed format has a certain gravitas. It may be more appropriate for serious study of a treatment philosophy.

As with our previous books, we have a clinical emphasis, showing cases or parts of cases to illustrate our techniques. For the first time we have chosen to include transfer cases. It is part of good orthodontic practice to be able to manage these patients well, and much can be learned from them. Almost all the line drawings were created by one author, and as with our earlier books, none of the images have been enhanced or changed.

If patients are to be well served in the future, there will be a need for guidelines in orthodontics. After years of experience, and endless trial and error, this is our attempt to produce some basic guidelines for those new to the specialty, and we hope this will not be seen as presumptuous.

Our treatment methods have been founded on science, going back as far as the 1970s, but over the years they have been modified by our experience in treating thousands of cases and by suggestions from colleagues worldwide. Taken together, we believe the coordinated techniques and appliances we recommend make up a reliable treatment philosophy. We use 'McLaughlin Bennett System 4.0' as a convenient term to describe our overall approach, as discussed in chapter 2.

As authors, we hope this series of books will be seen as a set of ground rules. Throughout this book we will be referring to our earlier books as B1, B2, and B3, and the titles are given on page 23. For the young professional they can be read as guidelines for high quality care. Above all, for the idealist in orthodontic training, they will offer a pathway to 'doing it right'. If you want to rise above the level of mediocrity in orthodontics, these three books are for you, young colleagues.

So here it is. This book covers our latest thinking and brings everything up to date. It is intended to be read along with our earlier books, and we hope you enjoy it!

John Bennett Rick McLaughlin

Acknowledgements

During the writing of this book we have spent many hours away from our families, and we are grateful for their love and understanding during this time.

We could not have produced the book without Patty Knecht's huge contribution. Patty worked tirelessly to assemble more than 700 photographic images, and used her expertise with Dolphin Imaging® to produce and check the cephalometric data for all the case reports. Dr. Paul Upatham's clinical expertise was invaluable in reviewing the material, and Laura Plante's assistance with editing and proofing was much appreciated.

For the technically minded, the material was written in Apple Pages® 4.05 and typeset using InDesign®. Most of the line drawings were by one author, using Freehand® and Illustrator®. However, we appreciate the help of Paige Thomas and the graphic design expertise of 'JD' Melville and at Ultradent, for the beautiful appliance illustrations used in chapter 4, on the cover, and for Figs. 5.23, 7.08 & 8.123.

We would also like to thank Opal for its efforts in designing the new appliance, and taking so many other steps to raise the level of patient care.

The color illustrations are mostly from our material, but we gratefully acknowledge those from Dr. Masatada Koga (Figs. 2.60 & 6.10), Dr. Anne-Marie Nafash (Fig. 8.10), Dr. Cheol-Ho Paik (Fig. 8.13), Dr. Hiroki Hayashi (Figs. 8.15 – 8.18) and Dr. Hugo De Clerck (Figs. 8.19 & 8.101).

For the typesetting and designs, we again enjoyed working with the team at Direct Approach, ably led by Jane Rose. Their experience and friendly advice were invaluable throughout the publishing process.

Finally, to our colleagues around the world who use the treatment method, and who have suggested refinements over many years, we express our immense gratitude. You know who you are, and you are part of the story!

John Bennett Rick McLaughlin

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CHAPTER 1

Treatment goals and the concept of ideal

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Treatment goals and the concept of ideal

This book has a main focus on treatment mechanics, but at the start it is useful to review treatment goals and the concept of 'ideal' (B2 p. 3). It is essential for the orthodontist to have a clear idea of what are considered to be ideal treatment outcomes. These are not reached in every case, but they should be the starting point for treatment planning.

The treatment process

It is a challenging task to position the dentition in the most appropriate place in the facial complex. The process involves the following:

- Establishing a general concept of 'ideal'
- Identifying the patient's problems, based on examination and records
- Noting the patient's main concerns
- Deciding if 'ideal' can be achieved and if it is to be the treatment goal
- If 'ideal' is not the aim, deciding a treatment goal for the case and noting why compromises are being accepted
- Explaining the treatment plan to the patient
- Motivating the patient, because each patient plays a part in reaching the treatment goal
- Treating the patient to the treatment goal.

Many patients or parents will express a clear idea of what changes they are hoping for as a treatment outcome.

These are termed 'the patient's main concerns', and it is important for the orthodontist to aim resolve them during treatment. Also, when discussing treatment goals, it is helpful to explain that treatment planning is not an exact process. Patient cooperation, treatment response, and growth, are all unpredictable factors which may prevent an ideal outcome (Fig. 1/01).

Many treatments can be planned for an ideal result, and will move uneventfully towards that goal, but for others, a less than ideal outcome will be the treatment goal. Some cases which start with an ideal goal, will end as less than ideal due to factors of cooperation, treatment response, and growth.

The patient's view

There are occasional patients who have their own firm views. They may wish to self-diagnose and treatment plan, and ask the orthodontist to treat accordingly. If these plans are considered detrimental by the orthodontist, they need to be discussed, because going down such a path frequently ends in disappointment for the patient and the orthodontist.

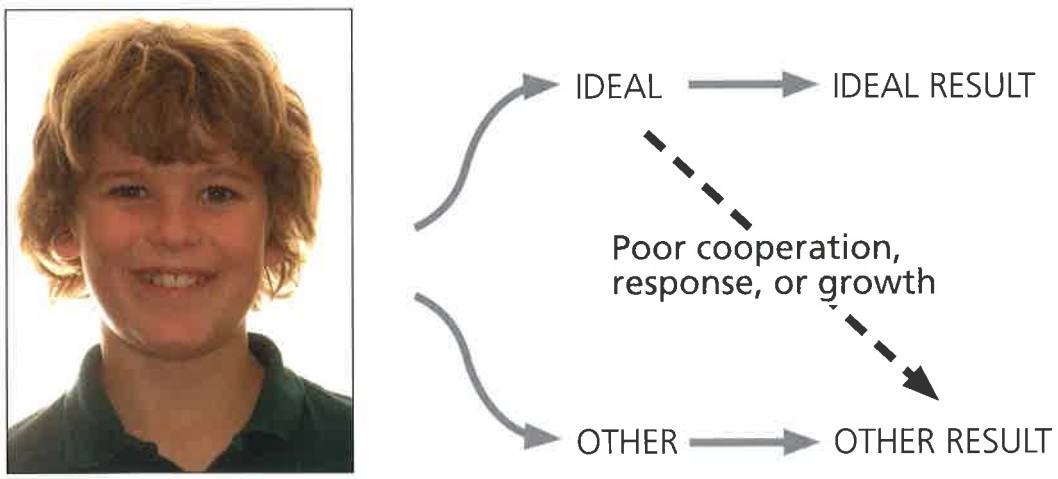

Fig. 1.01 Ideal treatment outcomes are not reached in every case, but they should be the starting point for treatment planning. Patient cooperation, treatment response, and growth, are all unpredictable factors which may prevent an ideal outcome. Some cases which start with an ideal goal will end with a result which is less than ideal, due to one or more of these factors.

Healthy temporomandibular joints (TMJs)

The temporomandibular joints are the cornerstone of any form of occlusal correction, including orthodontics, and there is a need to achieve harmony between the TMJs, the musculature, and the corrected dentition. Where possible, the ideal is to finish with healthy TMJs which have a normal range of movement, structural stability, and freedom from pain.

Fortunately, many orthodontic patients have healthy joints when they come for treatment, but it is necessary for the orthodontist to check them during the initial assessment. The examination includes palpation and assessment of the range of motion, along with deviations of the mandible during movement, and joint sounds. This information, a history, and any other concerns need to be noted. If the joints are healthy, the ideal treatment goal will be to maintain this during and after orthodontics. If they are unhealthy, the goal is to address the problems and to improve them as far as possible, either before and/or during orthodontics.

At the end of treatment the ideal is to have the condyles seated, uncompressed and centered in the fossae (CR) when the teeth are in centric occlusion (CO) i.e. maximum intercuspation (Fig. 1.02). In particular, the condyles should not be positioned too far distally at CO as has been recommended by some in the past (Fig. 1.03) because joint compression is a factor in condylar remodelling [1,2]. Significantly, many TMJ dysfunction patients have condyles which are posteriorly displaced [3,4].

It is the authors' view, although not documented by the majority of correlation studies, that if a result can be achieved with the condyles correctly centered at maximum intercuspation, there is a greater chance of healthy musculature and temporomandibular joints as well as occlusal stability. And if, at maximum intercuspation, the patient's condyles are displaced from this ideal position in any direction, particularly distally, there will be a greater predisposition toward temporomandibular disorders.

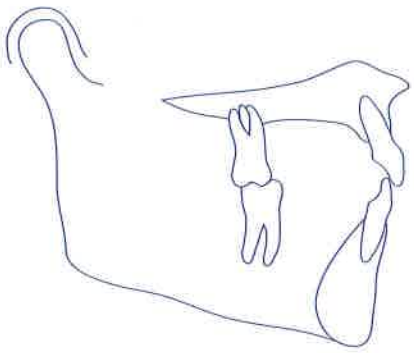

Fig. 1.02 The ideal treatment goal is to reach a result with the condyles seated, uncompressed and centered in the fossae (CR) when the teeth are in centric occlusion (CO).

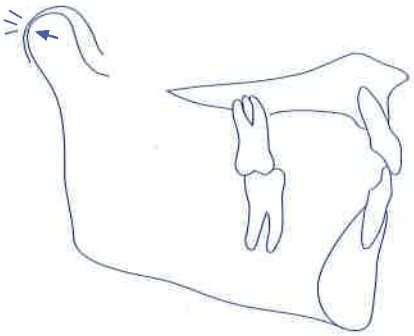

Fig. 1.03 Joint compression is a factor in condylar remodelling and many TMJ dysfunction patients have posteriorly displaced condyles.

Healthy oral musculature

The muscles of mastication should function normally in an ideal result. There should be no movements such as bruxism and clenching, which are considered outside or beyond normal function, and often referred to as parafunction. It is accepted that this results in wear facets and can lead to other problems associated with occlusal trauma. There should be no thumb or finger sucking activity, or hyperactivity of the mentalis muscle.

Normal tongue size, position, and activity are goals for an ideal result, and tongues are sometimes a challenge to the orthodontist. Speech therapy can be helpful, but in many cases it is difficult to achieve normal function. Ideally, the tongue size should be appropriate to the size of the oral cavity, and not oversize. At rest it should be held in the roof of the mouth, known as the 'neutral position' by speech therapists, and not in a forward position as often seen in open bite cases or in a low position associated with many Class III malocclusions. There should be no abnormal tongue thrusting during swallowing (Fig. 1.04).

Fig. 1.04 Tongues are sometimes a challenge to the orthodontist, and in many cases it is difficult to achieve normal function. Normal tongue, position, and activity are goals for an ideal result.

Facial balance and harmony

Patients are normally pleased to find that orthodontics is not just about teeth, and are interested to discuss facial appearance and possible avenues of improvement. Treatment planning starts with the face and the TMJs, and during treatment the aim is either to maintain or improve facial balance and harmony. There should be no deterioration due to tooth movements.

Tooth alignment cases. Many patients present with facial harmony, or with an appearance that is pleasing to them. They do not want facial change. For them, the ideal outcome will be to maintain their facial appearance during the necessary tooth movements. For these 'tooth alignment' cases, the malocclusion has to be corrected while causing no change in the face, and many cases fall into this category.

Defining ideal facial outcome. Other patients are seeking a favorable change in their facial appearance. Unfortunately it is not possible to define an ideal outcome for these individuals, because facial beauty comes in many forms, and depends on the human eye. Patients may have personal preferences, and their view of what is beautiful may be influenced by ethnicity, gender, age and other factors. Accordingly, facial change is discussed with tact and sensitivity, taking into account any personal preferences or cultural bias.

The limits of traditional cephalometry. It is a mistake to attempt to define an ideal facial outcome based on hard tissue cephalometric normals or tooth alignment. The commonly used cephalometric values, are mainly dental and skeletal measurements. They have minimal soft tissue emphasis and it is not logical to try to achieve facial beauty by aligning the teeth and meeting cephalometric normals because studies have shown no correlations [5–9]. Patients with a severe malocclusion may have pleasing facial harmony, and those with an ideal dentition may have an unsatisfactory facial appearance.

If ideal dental and skeletal values are achieved during treatment, there is no reason to expect the face will also be beautiful. It is important to be clear about this, because treatment on this basis may cause facial decline in some cases.

Soft tissue measurement. The authors accept the subjective nature of facial beauty and harmony. However, they believe it is necessary to scientifically measure the soft tissue components of a patient's profile, as well as the hard tissue aspects. This identifies the main areas of imbalance and objectively defines an ideal result for a patient.

To provide adequate soft tissue information, the authors use selected values from the study by Arnett and Bergman [8,9] and the later analysis by Arnett and coworkers, which is a research based and objective method of assessing facial profile [14]. The values were from a sample of adult Californian Caucasian males (20) and females (26) with Class I occlusions and 'reasonable facial balance'. The subjects in the study were analyzed in natural head position, with seated condyles and lips at rest, and significant differences were found between male and female values.

The sample was limited to adult Southern California Caucasians, but values can be determined for other populations, and the authors believe that the future lies with analyses of this type for various ethnic groups. Studies exist for Japan (in press), India [10] and Turkey [15].

The full Arnett analysis has a large number of measurements, and it is valuable for patients with significant facial imbalance, when they are being assessed for surgical orthodontic treatment [11]. For patients with less severe facial imbalance, requiring orthodontic treatment only, the authors use 14 selected values that relate to the upper and lower anterior segments, as well as the occlusal plane. The information gained in these key areas adds greatly to that obtained from traditional cranial base cephalometry. Combining the two approaches to facial assessment also shows the differences between information from natural head position and that obtained from cranial base measurements. There is truth in the observation 'the models tell you there is a malocclusion, and the face tells you how to correct it'. The 14 measurements to true vertical line (TVL) and occlusal plane are explained in detail on pages 19 to 22 and are shown in the case histories later in the book (Fig. 1.05).

Fig. 1.05 To provide adequate soft tissue information, the authors use selected measurements from a true vertical line (TVL) drawn through subnasale, with the patient in natural head position.

Correct static occlusion

Since the 1970s Andrews' six keys [12] have been the guidelines and the accepted goals for static occlusion, leading to a cusp-embrasure, or 'tooth-to-two-teeth', occlusion (B2 p. 201). The earlier work of Stuart described cusp-fossa, or 'tooth-to-one-tooth' occlusion (B2 p. 200) but this requires grooves in the occlusal surfaces of the premolars and molars, known as PKT grooves after Peter K. Thomas, and so is not appropriate as an orthodontic goal. For those seeking more information on this topic, the authors have described the two types of occlusion in greater detail in an earlier text (B2 p.199 – 207).

In recent years the standards of the American Board of Orthodontics (ABO – www.americanboardortho.com) have become widely accepted as the goals for ideal occlusion at the end of orthodontic treatment, and these may be relied upon as sound guidelines. They include the main features of Andrews' six keys, and describe additional requirements concerning tooth alignment, marginal ridges, bucco-lingual inclination, overjet, occlusal contacts, occlusal relationships, root angulations, and interproximal contacts. In the incisor region there is a requirement for 2 mm to 3 mm of incisor overbite and overjet.

Ideal incisor torque figures can be achieved in Class I average angle cases, but torque compensation is normally required to manage anteroposterior or vertical skeletal discrepancies (Figs. 1.06 – 1.09) as has been previously discussed by the authors (B3 p. 176).

To meet ABO standards the canines need to be upright in alveolar bone, and Class I 'when possible', allowing for exceptions such as malocclusions with agenesis of upper lateral incisors, where space has to be closed. Molars and premolars are required to have a flat curve of Wilson, to avoid 'hanging' palatal cusps, which cause interferences during lateral excursions.

Concerning archform, the ABO requirements state that over-expansion is to be avoided, and that the final archform should be shaped to the starting form of the patient's lower arch. These requirements form the guidelines for an ideal result.

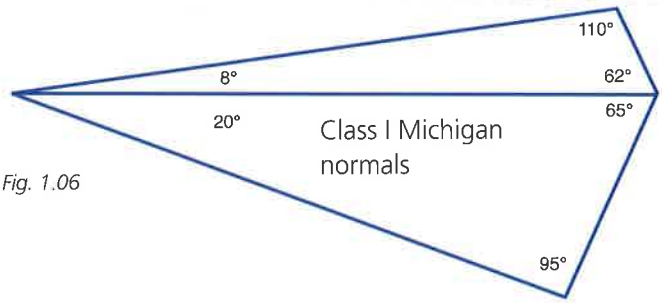

Fig. 1.06

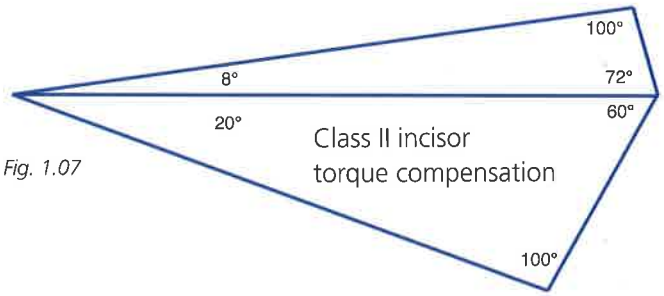

Fig. 1.07

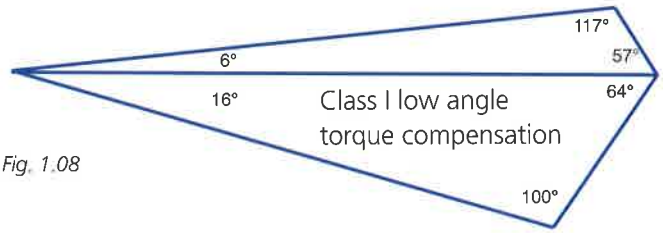

Fig. 1.08

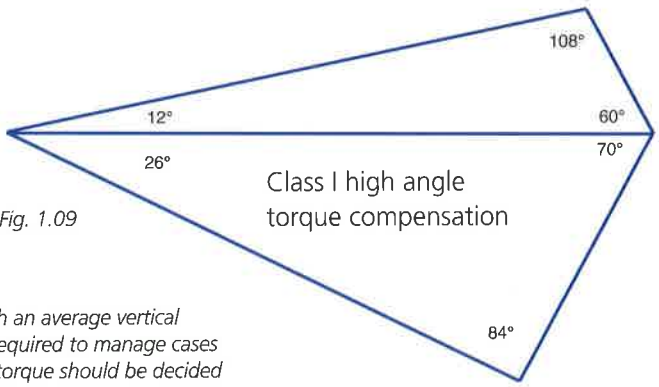

Fig. 1.09

Fig. 1.06 - 1.09 Ideal incisor torque figures can be achieved in Class I cases with an average vertical pattern, and this should be the goal. However, torque compensation is often required to manage cases with anteroposterior or vertical skeletal discrepancies, and the goal for incisor torque should be decided on a case by case basis. The chart for Class III incisor compensation is shown in chapter 14 on page 275.

Correct functional occlusion

Roth's landmark work in the 1970s and 1980s has been reviewed and commended by the authors (B2 p. 203 - 208). His goals may be used as guidelines for an ideal functional occlusion. He favored a mutually protected scheme of occlusion [13] and made six main recommendations:

- Orthodontic cases are best treated to a cusp-embrasure, or tooth-to-two-teeth relation, which is Class I as described by Angle. This is the same as Andrews' Class I molar relationship key.
- Centric occlusion (CO) or maximum intercuspation should coincide with the mandible in centric relation (CR).
- The occlusal forces during closure should be of equal magnitude for all posterior teeth, and directed along the long axes of the teeth.
- There should be minimal but sufficient anterior overbite to achieve anterior guidance and to disclude the posterior teeth by approximately 1 mm during function. The anterior teeth thus protect the posterior teeth from lateral stress.
- In straight protrusion the maxillary six anterior teeth should articulate equally and evenly with the eight anterior mandibular teeth, and all other teeth should be discluded.
- In lateral excursions the maxillary canines should function as guiding inclines to disclude the teeth on the non-working side after approximately 0.5 mm of group contact.

Fig. 1.10 Roth's goals include a cusp-embrasure occlusion, and a result where CO is coincident with CR. There should be minimal but sufficient anterior overbite to achieve anterior guidance and to disclude the posterior teeth by approximately 1 mm during function. Occlusal forces should be directed along the long axes of the teeth.

A healthy periodontium, with adequate bone support for the teeth

Where possible, after orthodontic treatment the gingival and periodontal tissues should be healthy, with all the teeth positioned in areas of adequate bone support. The periodontal health should be evaluated before treatment, and the goal should be to maintain or improve gingival tissue and alveolar bone levels. This requires patient motivation for proper plaque control and other oral hygiene measures, to avoid deterioration during treatment.

It is the responsibility of the orthodontist to avoid over-expansion, and to ensure that the final archform is shaped to the starting form of the patient's lower arch (page 88). As discussed above, this is an ABO requirement, and if it is not met there will be a risk of relapse and/or periodontal breakdown in the years after orthodontic treatment. The long-term use of bonded retainers is a method of preventing relapse of incisor alignment. However, these may maintain the teeth in an area which is unsupported by bone, and can be predicted to increase the risk of later periodontal problems, particularly in the canine regions (Fig. 1.11).

Fig. 1.11 It is a treatment goal to avoid over-expansion, and to ensure that the final arch form is shaped to the starting form of the patient's lower arch. Otherwise the patient will have an increased risk of relapse and/or periodontal breakdown in the years after orthodontic treatment.

Maintaining or improving the airway

Orthodontic procedures can influence airways and play a part in the management of sleep disorders. It is necessary for the orthodontist to ask appropriate questions during history taking and clinical examination, and if there are sleep apnea concerns, referrals can be made for further evaluation.

It is an accepted treatment goal to maintain or improve the airway during orthodontic procedures. With a narrow maxilla, there is the possibility to use rapid expansion to widen the upper airway, and if functional appliances are used for Class II cases, there may be signs of an improved pharyngeal airway if the mandible is further forward at the end of treatment. Conversely, mandibular setback surgery brings the risk of reducing the airway.

Stability of the result

Long-term stability is an accepted goal of good orthodontics. The orthodontist can achieve this in a high percentage of cases by identifying the true nature of the malocclusion (i.e. making a correct diagnosis) and then using sound orthodontic principles to achieve a full correction. Where necessary, key features need to be overcorrected, and in this way good stability can be expected in most cases, after suitable retention.

However, with some malocclusions there will be a clear risk of post-treatment changes and lack of stability, even after proper treatment has been provided, and it is important for the orthodontist to recognise these. The patient should be informed that it may be difficult to hold on to 100% of the improvement, and the reasons can be explained.

It is helpful to understand retention and post-treatment changes and be able to deal with them, as discussed in Chapter 14.

Fig. 1.12 With some types of malocclusion, such as Class III and open bite cases, there will be a risk of post-treatment changes and lack of stability, even after proper treatment has been provided.

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CHAPTER 2

The treatment method

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The treatment method

It should be a pleasure to provide orthodontic care. It can be possible to have a well-ordered and professional working environment, cruising through treatment sessions in an unhurried manner, and with consistently good results.

For this to happen there are requirements in three areas:

- First, there is a need to have an organized and well managed practice.
- Second, the record taking and treatment planning has to provide correct treatment plans for both tooth alignment and facial aesthetics.
- Third, a well-tried and effective system of treatment mechanics is needed, to deliver the planned result.

This book covers the third area, that of treatment mechanics, and it is planned as the authors' final words on the topic. There is sufficient published information available for a newcomer to use the method successfully (Fig. 2.01). It is recommended to practice the technique as described for the first two or three years, without introducing changes.

Concerning the first and second areas, there are texts in early preparation to cover these. This chapter is written for brevity, and summarizes the treatment philosophy as it is today – the third area. In anticipation of a book on treatment planning, at the end of this chapter there are five pages describing the analysis of soft tissues.

Publications	Stage in the development of the treatment method
1989, 1990, and 1991. *A series of papers published in the Journal of Clinical Orthodontics* [2,3,4].	These papers described the authors' use of sliding mechanics with the preadjusted appliance. Some of the main aspects of the current treatment method were given, including information on lacebacks, bendbacks, light forces, and working archwires with soldered hooks.
1993. Book 1 *Orthodontic treatment mechanics and the preadjusted appliance.* Mosby-Wolfe, London (ISBN 0 7235 1906X) Bennett J, McLaughlin R P.	This book brought together the concepts from the published papers, and for the first time showed stage by stage treated cases in color. There was a focus on full arch mechanics, light forces and group movement, and this text set out the fundamentals of the technique.
1997. Book 2 *Orthodontic management of the dentition with the preadjusted appliance.* Mosby, Edinburgh (ISBN 07234 32651) Bennett J, McLaughlin R P.	At 380 pages, this is the largest of the authors' books, and its importance equals the two later books. With 12 full cases, and 19 treatment sequences, it shows the mechanics in action, treating a range of malocclusions. In nine languages, and documenting the authors' prescription, it remains an important information source.
2001. Book 3 *Systemized orthodontic treatment mechanics.* Mosby (ISBN 072343171X) McLaughlin RP, Bennett JC, Trevisi HJ.	This is the most widely read of the authors' texts. Released in 2001, it has been reprinted in English a dozen times, and been translated into 16 languages. Written with Dr. Hugo Trevisi, it told the full story up to 2001. The principles remain valid, and provide a solid platform of effective mechanics, for those wanting to practice good orthodontics.
2014. Book 4 *Fundamentals of orthodontic treatment mechanics.* LeGrande Publishing (ISBN 978-0-9564555-2-9) Bennett J, McLaughlin R P.	This new book covers the latest thinking and brings everything up to date. It completes the story, and we have chosen 'McLaughlin Bennett System 4.0' as a convenient term to describe the present approach. The new book is the third part of a trilogy, and should be read along with our earlier books. We hope you enjoy it.

Fig. 2.01

The modern era of treatment mechanics began in the 1970s after Andrews [1] published his research on 120 non-orthodontic normals, and designed an appliance based on the findings. It was necessary to abandon the mechanics and force levels of the standard edgewise era, and develop new ones. The following pages summarize the present treatment method, and include some images from later chapters.

The prescription and slot size

The authors have used the same prescription for almost 20 years and have no reason to change it. The original tip, torque, and in-out values for the straight wire appliance (SWA), and the values for the Roth appliance, were developed for the heavy forces of standard edgewise (Fig. 2.02). The tip and torque were not ideal for light forces, sliding mechanics and group movement of teeth. In 1997 (B2) the authors published a prescription which was ideal for their mechanics, in their view. It was based on Andrews' science, and has stood the test of time, with widespread acceptance. It was used with the MBT™ appliance and is now used (unchanged) with high quality Avex™ brackets and tubes by Opal (Chapter 4).

The story of slot size remains the same since the 1980s. The .022 slot and .019 / .025 working wires deliver more efficient bite opening and better sliding mechanics.

Accuracy of bracket and tube manufacture

Appliances need to be accurately manufactured to the prescription (Fig. 2.03). In the mid 1990s the authors used mainly full size milled metal brackets, made in Munich, for excellent tooth control. During the 2000s there was a move to mid-size brackets and then low profile brackets, made by metal injection molding (MIM). These did not perform as well, possibly due to the smaller size or less accuracy in manufacture, or a combination of these two factors. There were concerns about oversized slots, and slot sides which were not parallel [21].

The brackets which the authors now recommend, have modified and corrected in-out values. This overcomes past difficulties with in-out in all bracket types – metal, clear and self-ligation. They are manufactured using the milling process known as computer numerical control (CNC) to obtain the required levels of slot accuracy and precise in-out (Chapters 3 & 4).

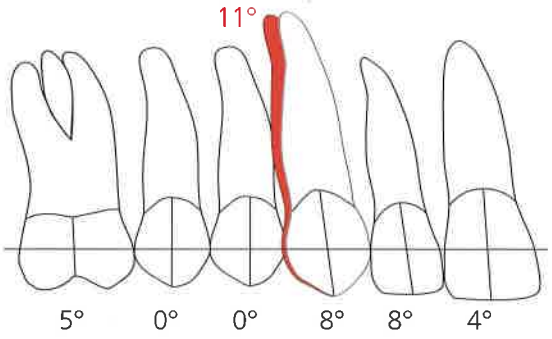

Fig. 2.02 The recommended tip values are shown here, and are based on the research findings. The tip values for SWA and the Roth appliance (for example the canine tip at 11° in red) were to be used with the forces of standard edgewise. They were not ideal for sliding mechanics and light forces.

Fig. 2.03 This case (page 164) and all the cases in this book were treated with appliances to the recommended tip, torque, and in-out values. The prescription works well, but precise bracket positioning and accurate manufacture are also needed for effective mechanics.

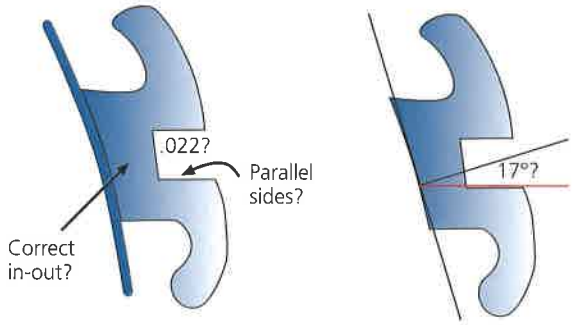

Fig. 2.04 It is important to use appliances which are accurately manufactured to the prescription. The brackets which the authors recommend, are manufactured using the milling process known as computer numerical control (CNC) for greater accuracy.

Tie wing brackets

The treatment method is most effective when used with high quality tie-wing brackets. Several self ligating types were evaluated in recent years, but the outcomes were not good. There were disadvantages due to increased size, complexity, cost, patient discomfort, vulnerability to breakage, unsuitability for indirect bonding, and reduced tooth control (B 4). These outweighed any possible advantages when using the recommended mechanics.

Fig. 2.05 The treatment method is most effective when used with high quality tie-wing brackets (left).

Lacebacks and bendbacks

Lacebacks and bendbacks continue to be recommended for anchorage control during levelling and aligning. Lacebacks (page 107) are used mainly in premolar extraction cases, or in some non-extraction cases where the canine apices are forward. They assist in control of canine crowns and can also produce some canine retraction.

Bendbacks (page 107) ensure patient comfort in the molar area. They also help to preserve anterior anchorage by restricting labial movement of the incisors, which is an unwanted tooth movement, except in some Class II/2 cases (Chapter 8). Bendbacks and lacebacks are normally used, if needed, until the rectangular steel archwire stage.

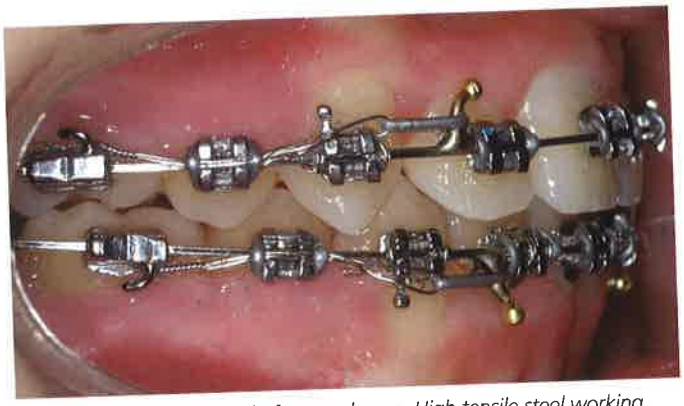

Fig. 2.06 A case at the end of space closure. High tensile steel working wires are in place with soldered ball hooks. Active tie backs have been used to provide light continuous forces during sliding mechanics. Intermaxillary elastics can be used when needed.

Sliding mechanics

The authors first described their use of sliding mechanics and group movement in a 1989 paper [2] with more details in 1993 (B1 p. 25). The same full arch approach continues to be used, with .019 / .025 steel working wires, carrying soldered hooks distal to the lateral incisor brackets (Fig. 2.06). Active tiebacks provide light continuous forces, to effectively move teeth (page 112). Later, passive tiebacks are used to hold spaces closed.

Currently, greater use is made of light elastomeric chains, late in the treatment, to maintain space closure as the case approaches appliance removal (Fig. 2.07). This prevents spaces from opening, and avoids patient disappointment.

Great attention is paid to wire quality. The mechanics work best with high quality wires with a high modulus of elasticity, particularly for the .019 / .025 steel working wires (page 91).

Fig. 2.07 Greater use is made of light elastomeric chains, late in the treatment. They prevent spaces from opening, which can cause patient disappointment. A passive tieback is in place in the lower arch to maintain space closure as the case approaches appliance removal.

Indirect bonding

Accurate bracket positioning is essential for effective treatment, and vertical accuracy is the most difficult to achieve [5]. Andrews used the center of the long axis of the clinical crown, and recommended this position for visual bracket placement. The authors used this method for some years, but reverted to charts and gauges in 1996, after which they found less need for repositioning (B2).

Indirect bonding is recommended (Fig. 2.08). It has many advantages, including optimal accuracy (Chapter 6) and the latest materials and light curing methods have made it easier. The Kalange [6] method is helpful when setting up molars and premolars for indirect bonding, using marginal ridges as a reference (page 71).

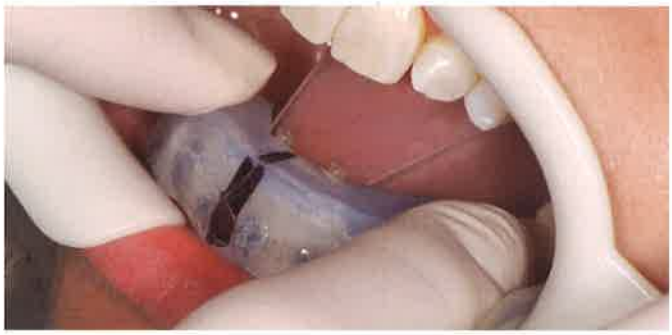

Fig. 2.08 Indirect bonding has many advantages, including optimal accuracy. The latest materials, such as Emiluma™ and Lumaloc™, and light curing with the Valo™ light, have made it easier.

Bonding methods to reduce white spot lesions

A different bonding technique is being used, with the aim of reducing or eliminating enamel decalcification during treatment (page 73). Previously, only a small area of each tooth surface was etched, sufficient for the bracket base (Fig. 2.09). The preferred method involves etching the whole labial surface and then covering it with a protective layer of sealant [7]. Good research takes time, but programs are underway [8] and there are indications that there are fewer white spot lesions with this method.

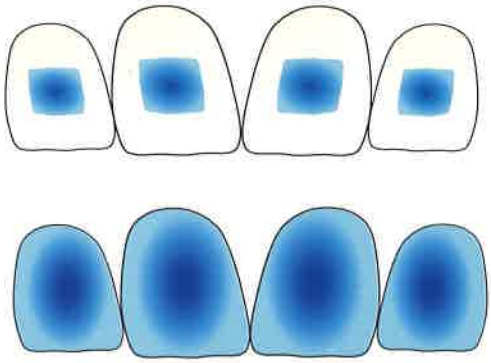

Fig. 2.09 Previously, only a small area of each tooth surface was etched, sufficient for the bracket base (above). The current method involves etching the whole labial surface (below) and then covering it with a protective layer of sealant.

Temporary anchorage devices (TADs) or plates

It is easy to combine TADs or plates with the treatment method, and there is no need to change the appliance or the mechanics (chapter 8). Miniscrews can be used at various stages in the treatment, if absolute anchorage is needed. They can serve to anchor molars during levelling and aligning (Fig. 8.14 page 110) or they can support the use of elastics or coil springs during sliding mechanics. Interestingly, surgical plates have proven to be a reliable and effective option (Fig. 2.10). They are normally fitted by oral surgeons, because the placement technique is more invasive than with TADs, and a surgical flap is required. They are very reliable, with a failure rate which is less than TADs [9].

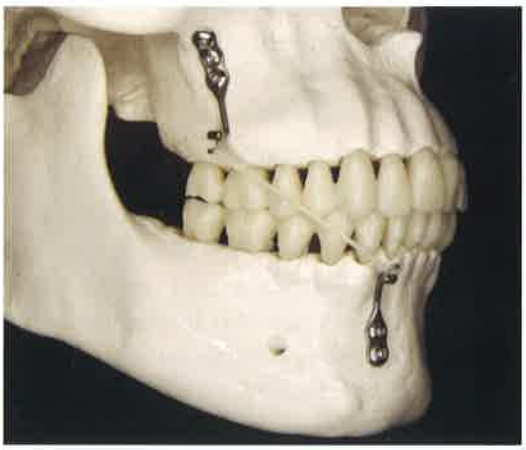

Fig. 2.10 Plates require a surgical flap for placement, and are normally fitted by oral surgeons. However, they are very reliable, with a failure rate which is less than TADs.
Photo of Bollard plates courtesy of Dr. Hugo De Clerck.

Arch form

The protocol with arch form is unchanged. A standard ovoid, tapered, or square form is selected for the case, and used in the early stages of treatment (B2 p. 77). Then an individual arch form (IAF) is made for each patient, and used from the working wire stage onwards for the rest of the treatment. The shape of the standard ovoid, tapered, and square wires is unchanged in the anterior part, but has been adjusted a little in the posterior area. The new forms have different widths in the molar areas, whereas previously all the shapes had the same width (Fig. 2.11).

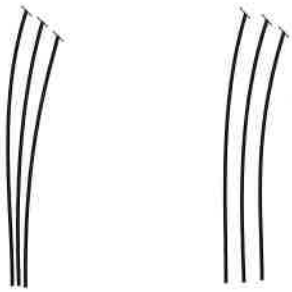

Fig. 2.11 The shape of the standard ovoid, tapered, and square wires is unchanged in the anterior part, but the forms have different widths in the molar areas (right). Previously (left) all the arch forms had the same posterior widths.

Archwire quality

The heat activated nickel titanium (HANT) wires play an essential part in the treatment method, and an improved quality of HANT wire is now used, with less inconsistencies and variation. A huge number of HANT wires are used, either as .016 round or as .019 / .025 rectangular types. There have also been advances with the quality and accuracy of the steel wires, which is a big step forward (page 91). Wire with increased spring temper brings new standards of control for overbite, torque, and arch form, and the new wires are diamond drawn for a smooth finish.

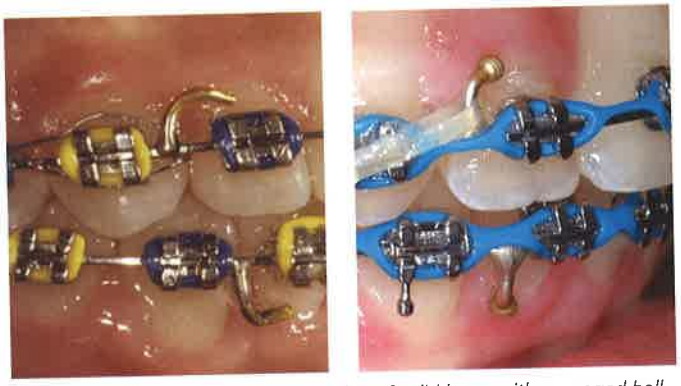

Fig. 2.12 The new type of hook (right) is of solid brass with a swaged ball end. It is more comfortable for the patient than the previous bare soldered hooks, and placement of elastics is easier.

Archwire hooks (posts)

Along with better overbite control, the new .019 / .025 posted steel wires have the advantage of posted ball hooks. The new hooks are of solid brass with a swaged ball end, and are more comfortable than bare soldered hooks (Fig. 2.12). The soldering process eliminates annealed and softened areas, which in the past have adversely affected the mechanical properties and the performance of archwires.

Crown form and enamel reshaping

The authors make greater use of interproximal enamel reduction (IPR) than in the past. It is an important treatment option to deal with crowding in orthodontics, particularly in adult cases (page 144). It is sometimes known as the 'silver bullet' and when correctly performed, it is a safe procedure [10,11]. It allows a higher number of cases to be treated without extracting teeth, and is often used to correct tooth size discrepancies or to reshape triangular teeth, to reduce the incidence of dark triangles. Composite build up remains an important treatment option to manage tooth size discrepancies and ensure a good tooth fit at the end of treatment.

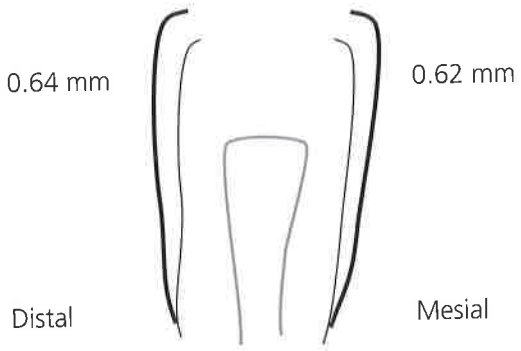

Fig. 2.13 The authors make greater use of interproximal enamel reduction (IPR) than in the past, and when correctly performed, it is a safe procedure (page 149). It is an important treatment option to deal with crowding in orthodontics, particularly in adult cases.

Settling the case

During the settling stage of treatment, the orthodontist needs to make the final tooth movements which are required to complete the case, and there are two aspects to this. First, there is a need to identify what has to be done. Second, there is a need to accomplish this, without losing what was achieved earlier in the treatment.

When finishing the case, it is important to have a protocol that minimizes negative changes while the teeth settle. There are options that are frequently used in the upper and lower arches during settling, and they are applied in different combinations, depending upon the needs of the case (Chapter 12).

Fig. 2.14 There are frequently used options during settling. Here there is a lower .016 HANT wire, with a sectional .014 steel wire 2 X 2 for the upper incisors. Up and down 4 ounce quarter inch elastics are being used to settle the buccal occlusion.

Post treatment management

Unfortunately, there is little research available in the literature about retention and the management of cases after active treatment is finished. However, this is a very important topic, because changes often occur. If they are managed well, there will be little effect on the smooth running and efficiency of the practice, and recommendations are made in the final chapter of the book.

Retention should be uneventful, but if changes occur, the authors make a distinction between 'relapse' and 'post-treatment change'. It is helpful to have a retention protocol, and a range of options to deal with any post treatment changes, according to the needs of the case. For example, there may be a requirement to recover incisor alignment or the correction of a deep bite after relapse or post treatment change (Chapter 14).

Fig. 2.15 Retention should be uneventful, but if changes occur, it is necessary to make a distinction between 'relapse' and 'post-treatment change'. A clear retention protocol is used, with a range of options available, depending on the needs of the case (Chapter 12).

Airways and sleep apnea

The orthodontist has a responsibility to maintain or improve the airway during treatment, and there has been an increased focus on this in recent years. Detailed discussion is beyond the scope of this text on treatment mechanics. However, the authors maintain an awareness of airways and sleep disorders, and enquire about this during history taking and clinical examination. If there is a positive response to these questions, then referrals are made for evaluation.

Additionally, during treatment planning, they keep in mind that rapid maxillary expansion or functional appliances [12] may produce some airway improvement, along with the orthodontic changes.

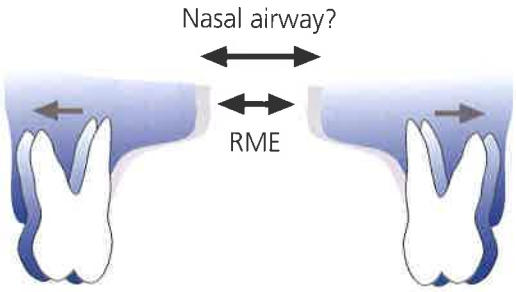

Fig. 2.16 The use of rapid maxillary expansion or functional appliances may lead to airway improvement, along with the orthodontic changes. Orthognathic surgery may have a positive or negative effect on the airway, and needs careful planning.

Soft tissue cephalometric analysis (STCA)

This book is about treatment mechanics, but some comments on cephalometry are included here, ahead of the first of the treated cases.

Conventional cranial base cephalometry has served the specialty well for years. However, it has limitations because the human face is made up of hard tissues, covered by a draping of soft tissues. The weaknesses of cranial base cephalometry are (i) that the cranial base is used for measurements, and it is different from patient to patient and (ii) it provides little or no information on the soft tissue components of the face.

To make cephalometry more useful for orthodontic cases, the authors use 14 anterior segment numbers from the studies by Arnett and Bergman [13,14]. These will be referred to as 'STCA values' in the text. The 14 values bring things together, and give good supplemental information on what we are doing with the face.

The use of conventional cephalometric values combined with the STCA anterior segment numbers has been favoured by the authors for some time now. It is an effective method of obtaining the most information from a cephalometic radiograph.

The STCA values are derived from radiographs of adults at natural head position (NHP), with a wax bite in centric relation, and with lips at rest. NHP has been shown to be reliable, and there are methods of correctly positioning the patient's head. Many studies are available concerning natural head position, and various methods of establishing it have been described [15–18]. A well accepted method is to ask the patient to look in a mirror in a reflection of their eyes, moving the head up and down by decreasing amounts, until a final posture is established. The clinician may need to assist with some minor posturing, in some cases.

If the cephalometric radiograph has not been taken in this position, it can be reoriented to NHP by the orthodontist with reasonable accuracy. This concern should not discourage the use of the analysis, given the importance of the information that is available to the orthodontist. It is a simple matter to reorientate the image (Fig. 2.18) and then draw the vertical line (TVL) through subnasale.

The true vertical line through subnasale, with the image at NHP, is on average approximately 8.5 mm from soft tissue glabella. A majority of the measurements in the analysis are then based on this TVL line. The measurement of the occlusal plane is discussed later in this chapter (page 22)

The colors show the difference from the ideal, and there are values for males and females.

- Black = 0 – 1 standard deviation (SD)
- Green = 1 – 2 standard deviations (SDs)
- Blue = 2 – 3 standard deviations (SDs)
- Red = 3 or more standard deviations (SDs)

The case reports show an upper and a lower triangle on the left of the conventional tracing (Fig. 2.17). These represent the palatal, occlusal and mandibular planes, as well as the upper and lower incisor long axes [20]. A 'Wits' value shows the dental base discrepancy, with Class 1 normal being -1 mm for males and zero for females [19,24].

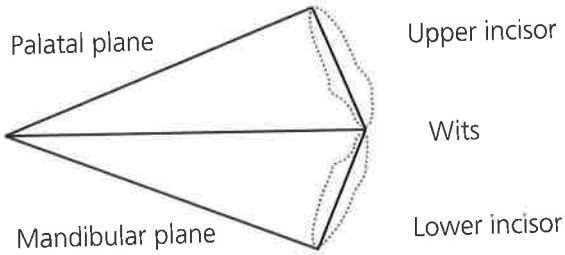

Fig. 2.17 An upper and a lower triangle, based on Fastlght's work, with a Wits value from Jacobsen's study.

Fig. 2.18 If the cephalometric radiograph has not been taken in the correct position, it can be reoriented to NHP by the orthodontist with reasonable accuracy. This concern should not discourage the use of the analysis, as it provides important information.

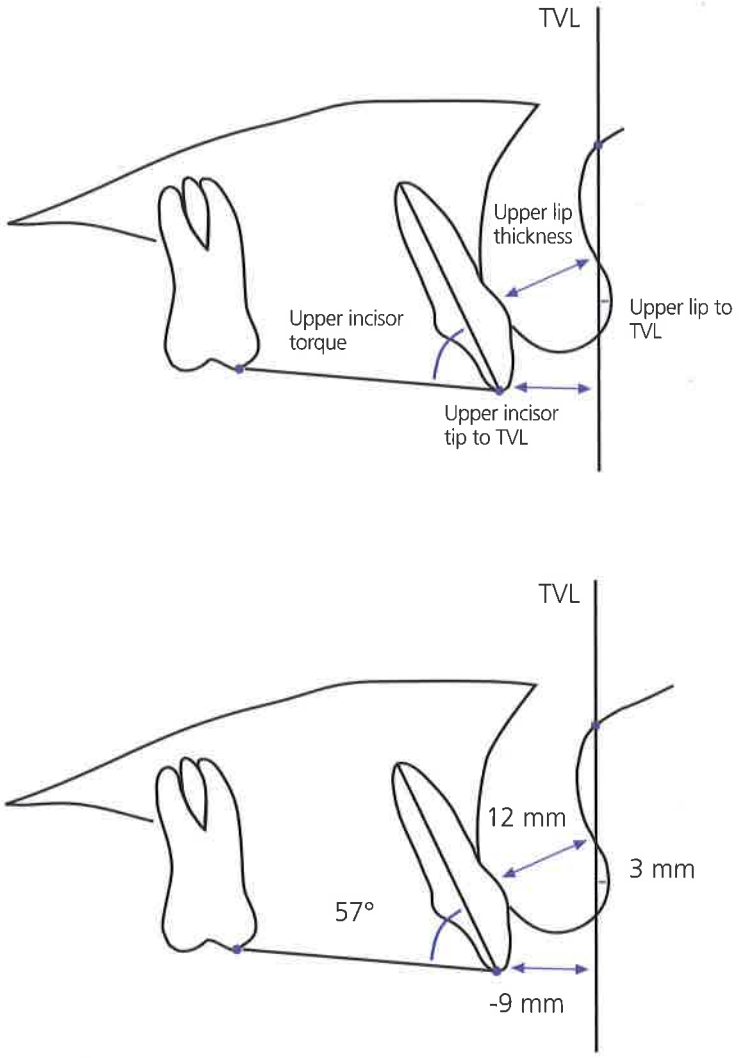

Fig. 2.19 This figure shows the mean measurement values for females. The male means are similar, and the male and female STCA standard deviation values are listed below. Torque is measured to the maxillary occlusal plane (page 22).

Upper anterior segment horizontal numbers

The four upper anterior segment horizontal numbers include:

- The upper incisor long axis angle to the maxillary occlusal plane.
- The distance from the upper incisor tip to TVL.
- Upper lip thickness with the lips at rest.
- Prominence of the upper lip relative to TVL.

Female STCA research values and (means)

↑ Incisor torque to occl. plane 54.3° to 59.3° (57°)
↑ Incisor tip to TVL -11.4 mm to -7.0 mm (-9)
↑ Lip thickness 10.8 to 14.4 mm (12)
↑ Lip to TVL 2.5 mm to 4.9 mm (3)

Male STCA research values and (means)

↑ Incisor torque to occl. plane 54.8° to 60.8° (57°)
↑ Incisor tip to TVL -13.9 mm to -10.3 mm (-12)
↑ Lip thickness 13.4 to 16.2 mm (14)
↑ Lip to TVL 1.6 mm to 5.0 mm (3)

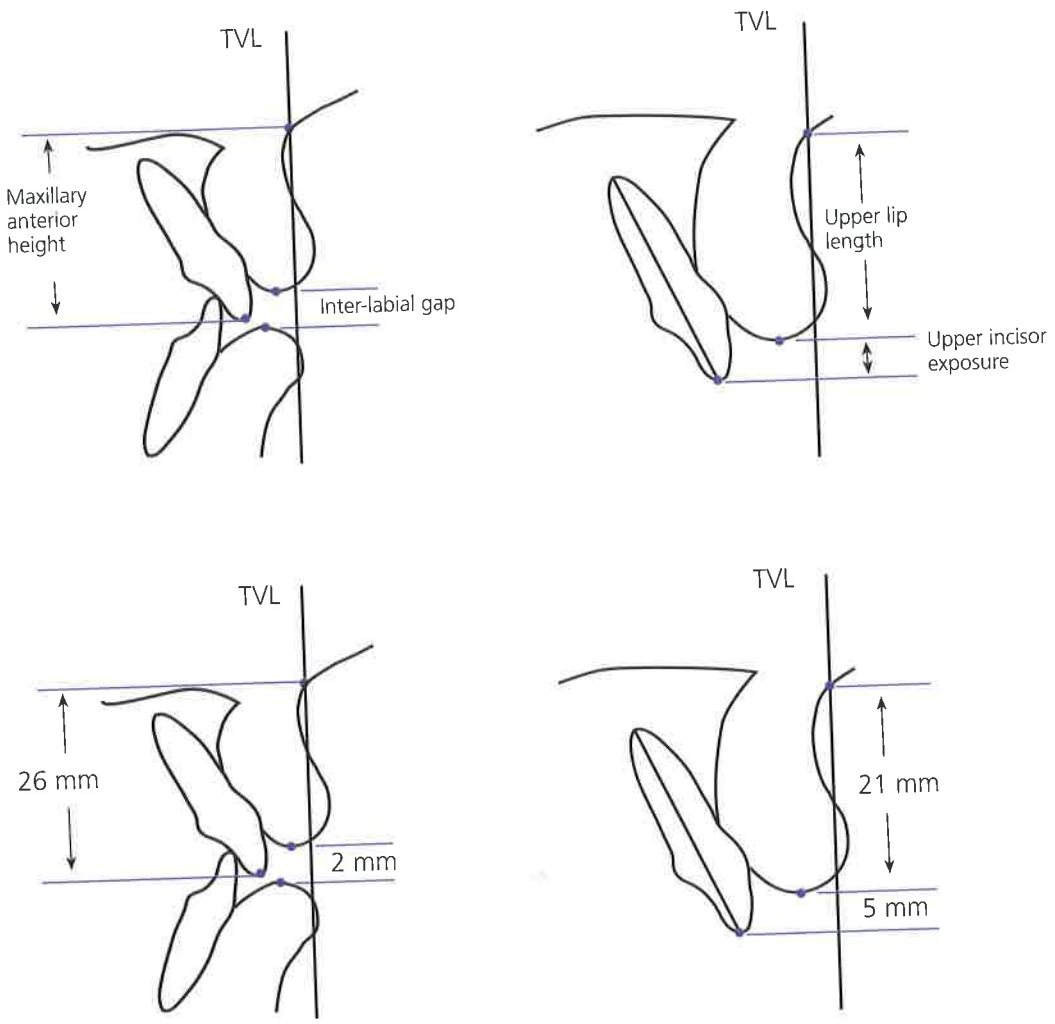

Fig. 2.20 This figure shows the mean measurement values for females. The male and female STCA standard deviation values are listed below.

Upper anterior segment vertical numbers

The four upper anterior segment vertical numbers include:

- Maxillary height (perpendicular length from subnasale to the tip of the upper incisor).
- Upper lip length.
- Incisor exposure.
- Inter-labial gap (the distance between the lips at rest).

Female STCA research values and (means)
Max. anterior height 23.6 mm to 27.8 mm (26)
↑ Lip length 19.1 mm to 22.9 mm (21)
↑ Incisor exposure 3.1 mm to 6.3 mm mean (5)
Inter-labial gap 2.0 mm to 4.0 mm (2)

Male STCA research values and (means)
Max. anterior height 25.2 mm to 31.6 mm (28)
↑ Lip length 21.9 mm to 26.9 mm (24)
↑ Incisor exposure 2.7 to 5.1 mm mean (4)
Inter-labial gap 1.3 mm to 3.5 mm (2)

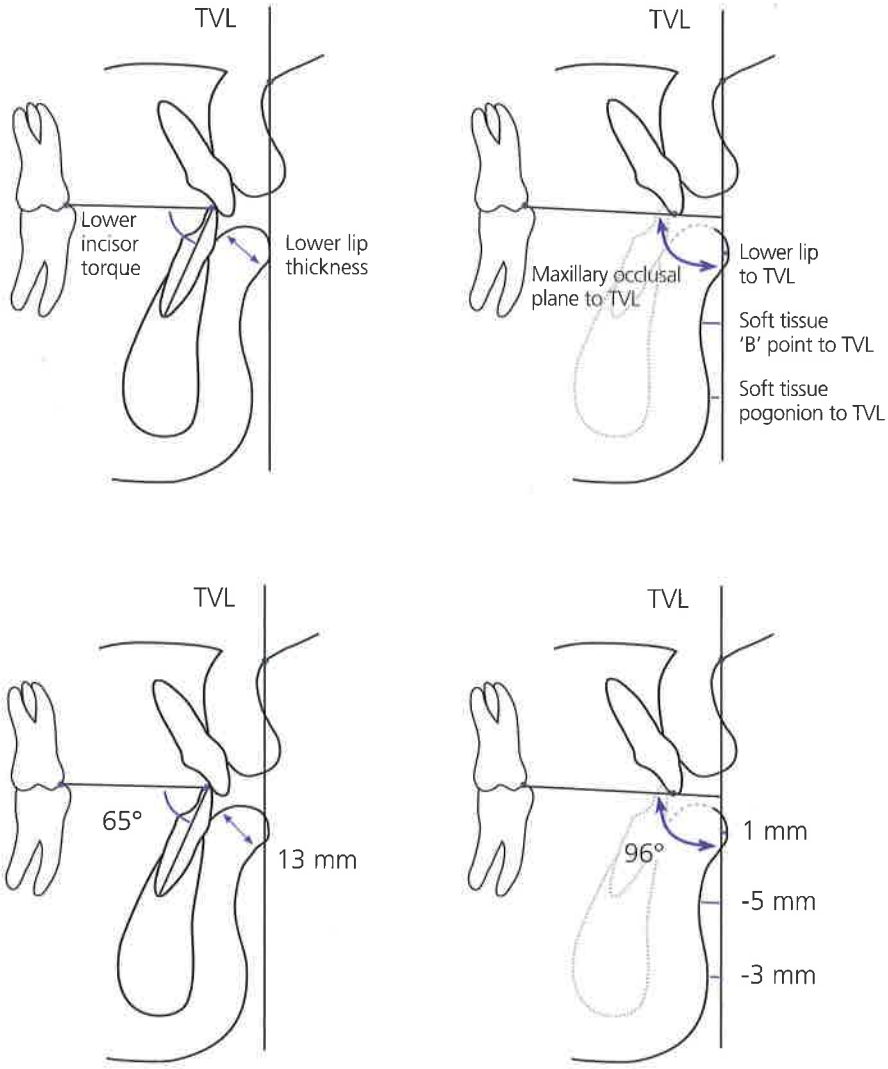

Fig. 2.21 This figure shows the mean measurement values for females. The occlusal plane to TVL is measured using the maxillary occlusal plane. Lower incisor torque is to the mandibular occlusal plane. The male and female STCA means and standard deviation values are listed below.

Lower anterior segment numbers

The six lower anterior segment numbers include:

- Lower lip thickness.
- Lower lip prominence to TVL with lips at rest.
- The distance from soft tissue B point to TVL.
- The distance from soft tissue pogonion to TVL.
- The angle of the long axis of the lower incisor to the mandibular occlusal plane.
- The occlusal plane angle, determined by the angle formed between the maxillary occlusal plane and TVL.

Female STCA research values and (means)
Occlusal plane to TVL 93.8° to 97.4° (96°)
↓ Incisor torque to occl. plane 61.1° to 67.5° (65°)
↓ Lip thickness 12.2 to 15.0 mm (13)
↓ Lip to TVL -0.5 mm to 3.3 mm (1)
Soft tissue 'B' point -6.8 mm to -3.8 mm (-5)
Soft tissue pogonion -4.5 mm to -0.7 mm (-3)

Male STCA research values and (means)
Occlusal plane to TVL 93.6° to 96.4° (95°)
↓ Incisor torque to occl. plane 60.0° to 68.0° (64)
↓ Lip thickness 13.4 to 16.2 mm (15)
↓ Lip to TVL -1.6 mm to 3.2 mm (1)
Soft tissue 'B' point -8.7 mm to -5.5 mm (-7)
Soft tissue pogonion -5.3 mm to -1.7 mm (-3)

Methods of measuring the occlusal plane

There are various definitions of occlusal plane. Strictly speaking it is not a true plane, but is often a curved surface. For the occlusal plane, a line is drawn joining two reference points on the cephalometric radiograph, representing a mean of the curvature of the surface [22]. Surgeons frequently receive cases after the curve of Spee has been levelled, so the curve is often not an issue for them.

Bisected occlusal plane. This is a line drawn through the cusp tips of upper and lower first molars to midway between the incisal edges of the upper and lower central incisors. Effectively this is bisecting the overbite [23].

Functional occlusal plane. This is defined as a line drawn through the occlusal surfaces of the maxillary and mandibular first permanent molars and first and second premolars, or first and second primary molars [23].

Mandibular occlusal plane. This is a line drawn joining the cusp tips of the lower first molars to the incisal edges of the lower central incisors [23].

Maxillary occlusal plane. This is a line drawn joining the cusp tips of the upper first molars to the incisal edges of the upper central incisors [23].

Downs described measurement of the occlusal plane, using the bisected plane above. He suggested using a line drawn from the bisection of the overlap of the mesio-buccal cusps of the upper and lower first molars to the bisection of the overlap of the incisors (primarily the central incisors) on a cephalometric tracing. The rational was that this would be the most practical way to minimize the effect of varying amounts of overbite curve, which, in turn, allowed for a more accurate evaluation of changes that occurred in the occlusal plane relative to growth and treatment. This method helps to avoid the levelling of the curve.

Ricketts proposed the use of a more posterior occlusal plane, from the bisection of the overlap of the first bicuspids to the bisection of the overlap of the first molars. This eliminates most of the curve issue, and is much better for open bites, if incisor movement occurs. It is described as the functional occlusal plane above.

The STCA values use the maxillary occlusal plane for measurements, except for lower incisor torque. Here, the mandibular occlusal plane is used.

The use of true vertical line (TVL)

A few definitions are included concerning the use of TVL.

Subnasale. This is the point in the mid sagittal plane where the base of the columella of the nose meets the upper lip [23].

Glabella. As a hard tissue measurement, this is the most prominent point of the anterior contour of the frontal bone in the midsagittal plane [23]. 'Soft tissue glabella' describes the most prominent point on the soft tissue covering glabella.

Natural head position. This is a standard orientation of the head that is reproducible for each individual and is used during analysis of cephalometric morphology. The concept was introduced by Moorrees and Kean in 1958 [23].

Male STCA values [13,14]

↑ Incisor torque to occl. plane 54.8° to 60.8°
↑ Incisor tip to TVL -13.9 mm to -10.3 mm
↑ Lip thickness 13.4 to 16.2 mm
↑ Lip to TVL 1.6 mm to 5.0 mm

Max. anterior height 25.2 mm to 31.6 mm
↑ Lip length 21.9 mm to 26.9 mm
↑ Incisor exposure 3.9 mm mean
Inter-labial gap 1.3 mm to 3.5 mm

Occlusal plane to TVL 93.6° to 96.4°
↓ Incisor torque to occl. plane 60.0° to 68.0°
↓ Lip thickness 13.4 to 16.2 mm
↓ Lip to TVL -1.6 mm to 3.2 mm
Soft tissue 'B' point -8.7 mm to -5.5 mm
Soft tissue pogonion -5.3 mm to -1.7 mm

Female STCA values [13,14]

↑ Incisor torque to occl. plane 54.3° to 59.3°
↑ Incisor tip to TVL -11.4 mm to -7.0 mm
↑ Lip thickness 10.8 to 14.4 mm
↑ Lip to TVL 2.5 mm to 4.9 mm

Max. anterior height 23.6 mm to 27.8 mm
↑ Lip length 19.1 mm to 22.9 mm
↑ Incisor exposure 4.7 mm mean
Inter-labial gap 2.0 mm to 4.0 mm

Occlusal plane to TVL 93.8° to 97.4°
↓ Incisor torque to occl. plane 61.1° to 67.5°
↓ Lip thickness 12.2 to 15.0 mm
↓ Lip to TVL -0.5 mm to 3.3 mm
Soft tissue 'B' point -6.8 mm to -3.8 mm
Soft tissue pogonion -4.5 mm to -0.7 mm

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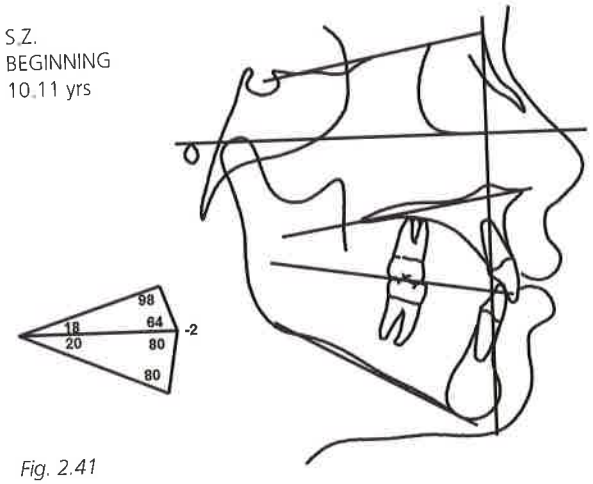
The authors wish to acknowledge that reference numbers 13 and 14 on page 23 are incorrect. They reference the statement on page 18 as follows: "To make cephalometery more useful for orthodontic cases, the authors use 14 anterior segment numbers from the studies by Arnett and Bergman."

The correct reference should read: G. William Arnett, DDS, FACD, Jeffery S. Jelic, DMD, MD, Jone Kim, DDS, MS, David R. Cummings, DDS, Anne Beress, DMD, MS, C. MacDonald Worley, Jr, DMD, MD, BS, Bill Chung, DDS, and Robert Bergman, DDS, MS. 1999 Soft tissue cephalometric analysis: Diagnosis and treatment planning of dentofacial deformity AJODO 116 (3): 239-53

Case report SZ

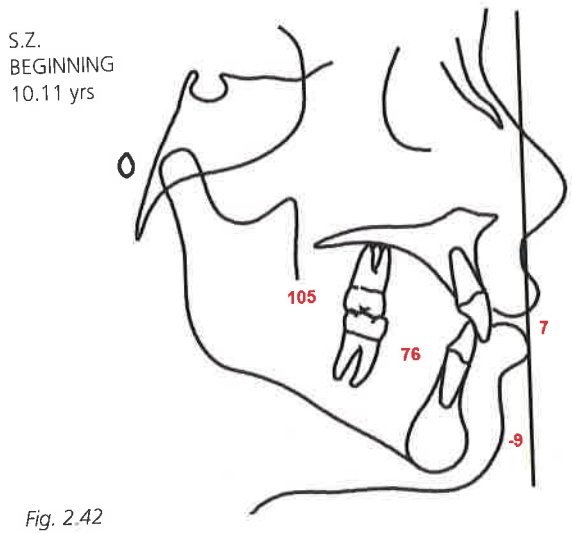
A female patient aged 10.11 years presented with a mildly convex facial profile and an increased lower facial height. Frontally, the patient was short on the right side of her face, compared with the left side. Her smiling photograph showed a slight excess of gingival tissue.

Her posterior segments were Class I, her upper and lower incisors were retroclined, and her overbite was moderately deep. There was lower anterior crowding. The panoramic radiograph showed well shaped condyles, a healthy dentition, good bone support and the developing third molars.



SNA 84°
SNB 79°
ANB 5°
A-N ⊥ FH 5 mm
Po-N ⊥ FH 2 mm
WITS -2 mm
GoGn SN 35°
FM 29°
MM 38°
↑1 to APo 4 mm
↓1 to APo 0 mm
↑1 to Max Plane 98°
↓1 to Mand Plane 80°

Fig. 2.41



↑ Incisor torque to occl. plane 60°
↑ Incisor tip to TVL -12
↑ Lip thickness 14 mm
↑ Lip to TVL 3 mm

Max. anterior height 28 mm
↑ Lip length 22 mm
↑ Incisor exposure 7 mm
Inter-labial gap 2 mm

Occlusal plane to TVL 105°
↓ Incisor torque to occl. plane 76°
↓ Lip thickness 13 mm
↓ Lip to TVL 0 mm
Soft tissue 'B' point -8 mm
Soft tissue pogonion -9mm

Fig. 2.42

The conventional cephalometric tracing confirms that the skeletal pattern was high angle. Horizontally, the skeletal pattern was Class I, and dentally the incisors were retroclined. The Arnett anterior segments showed slightly retruded incisor positions, but adequate lip thickness to provide good lip projection. The mandibular plane was steep, resulting in slight chin retrusion.

Fig. 2.43

Fig. 2.44

Fig. 2.45

Fig. 2.46

Fig. 2.47

Fig. 2.48

Fig. 2.49

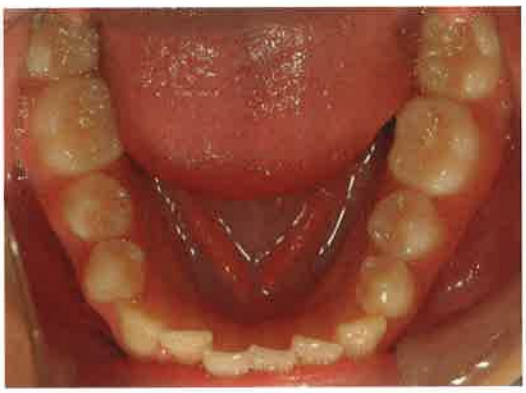


Fig. 2.50

Fig. 2.51

The treatment plan for the patient was to use full indirect bonded appliances, with turbos on upper central incisors (page 172). Treatment would be started with IPR in lower anterior area, and sectional wires on the lower arch. Upper and lower arches would be leveled and aligned and second molars would be included when erupted. Class II elastics would be used as indicated.

Indirect bonding was used (Figs. 2.55A & 2.60) and brackets were set up using the recommended methods (Chapter 6). There was lower interproximal reduction from the mesial of the lower left canine to mesial of lower right canine (Chapter 9). IPR is normally completed in the lower arch in the beginning of the case in this way, to allow proper lower incisor positioning without expansion of inter-canine width (page 109). In the upper arch a .016 heat activated wire (HANT) was placed. In the lower arch .014 sectional stainless steel wires were used, with underlying lace backs from lower first molars to lower canines. Wires were not placed in the lower incisor brackets until the IPR was completed. After IPR, a .016 HANT wire was placed in the lower arch. The .016 HANT wires are normally used in a tapered arch form (page 88) and left in place for one or two 4 to 6 week intervals. Bendbacks were placed distal to the upper molars to control arch length and prevent proclination of the upper incisors (Chapter 8).

The .019 / .025 heat activated wires are selected from the range of oval, tapered and square, based on the patient's lower arch form at the start of treatment (Chapter 7). In this case ovoid wires were used. These were left in place for two 4 to 6 week intervals. Occasionally a .016 / .025 HANT wire can be used before the .019 / .025 HANT wire, if lighter forces are required.

Before placement of .019 / .025 stainless steel wires, an appointment is scheduled for bracket assessment and repositioning, if needed. A panoramic radiograph is taken to evaluate root positions. If indicated, a progress cephalometric X-ray can also be taken. After repositioning, the .019 / .025 HANT wire is replaced for one visit. If repositioning is extensive, then a .016 HANT wire may be needed.

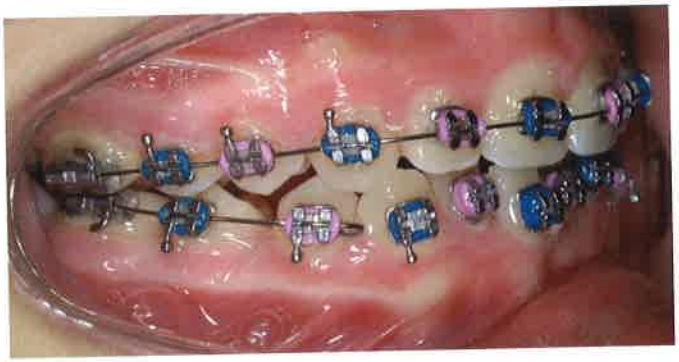


Fig. 2.52

Fig. 2.55 A Indirect bonding (on a different patient).

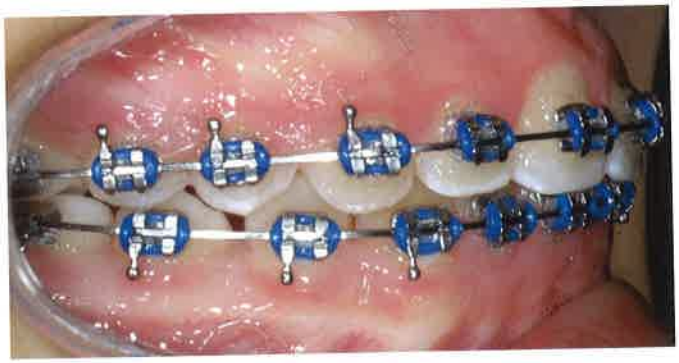


Fig. 2.57

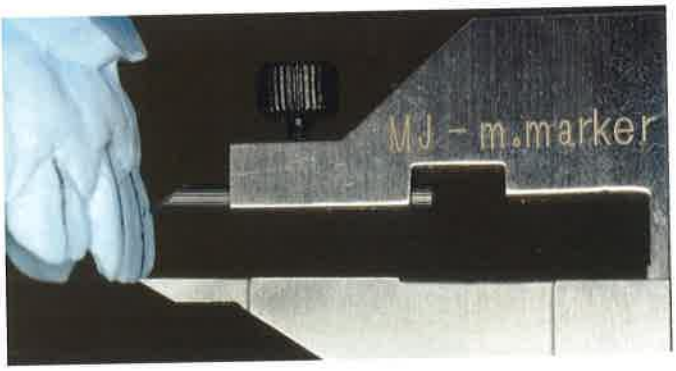


Fig. 2.60 Gauges were used for bracket positioning. Photo courtesy of Dr. Masatada Koga

Fig. 2.53

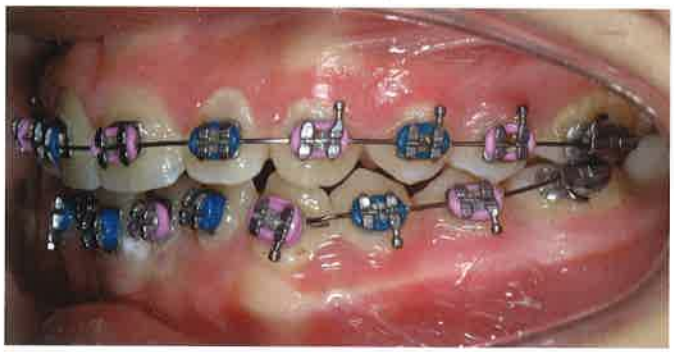


Fig. 2.54

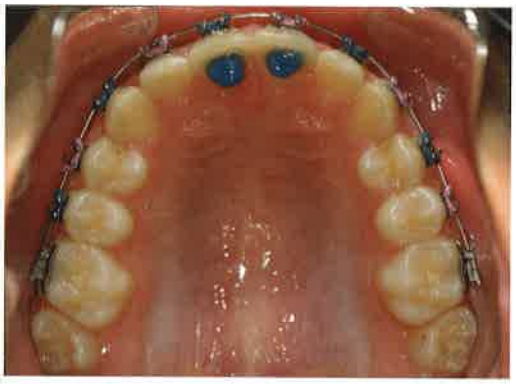


Fig. 2.55

Fig. 2.56

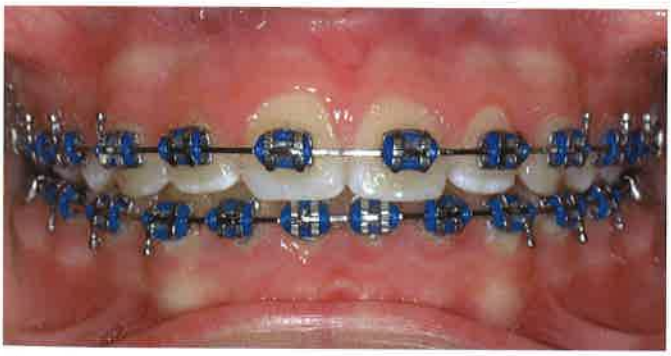


Fig. 2.58

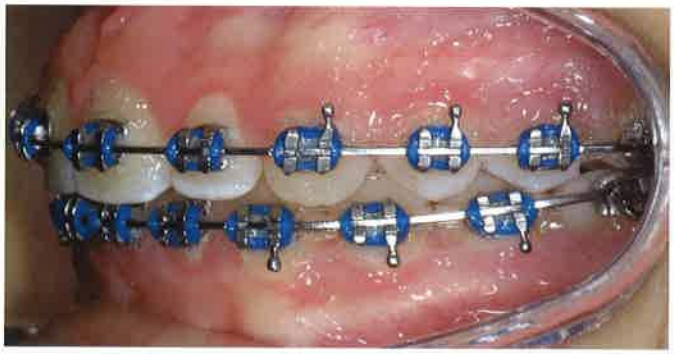


Fig. 2.59

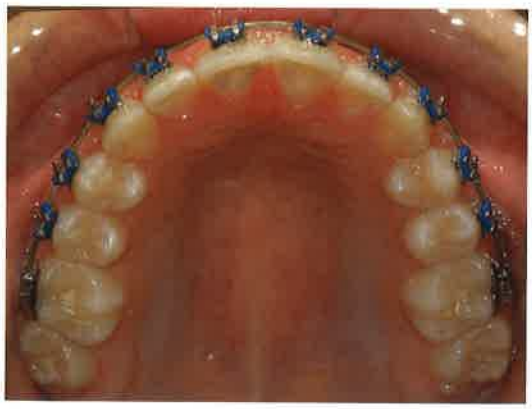


Fig. 2.61

Fig. 2.62

Upper and lower .019 / .025 rectangular steel wires were placed with passive tiebacks (Figs. 2.63 – 2.65). The lower wire was customized to an ideal arch shape for the patient (Chapter 7), using a wax impression of the lower brackets (Fig. 2.66). The upper wire was then coordinated to the lower wire. The working .019 / .025 wires are placed and remain in place while any spaces are closed and arches are leveled ideally. When needed, various intermaxillary elastics are used to correct inter-arch discrepancies.

A small amount of interproximal reduction was carried out in the upper anterior segment. If required, IPR is carried out near the end of treatment, when lower incisors are correctly positioned, buccal segments are correct, and anterior overjet and overbite can be accurately assessed. A .016 HANT wire was placed in the lower arch to allow the arch form to settle. An upper .014 round steel wire was placed and a light elastic chain was placed to maintain space closure. Molar offsets were placed mesial of the upper first molars to prevent rotations (Fig. 2.72) and normal finishing procedures were followed (Chapter 12). Light elastomeric chain was used in the upper arch to prevent any spaces from opening while the occlusion settled before appliance removal.

The final panoramic radiograph (Fig. 2.84) showed third molars developing with adequate space. The mesial roots of the lowers were maturing ahead of the distal roots (Fig. 2.72A) suggesting a favorable rotation pattern during eruption (B2 p. 31).

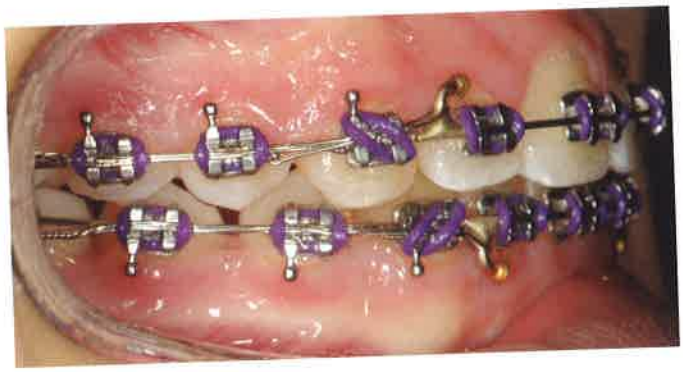


Fig. 2.63

Fig. 2.66

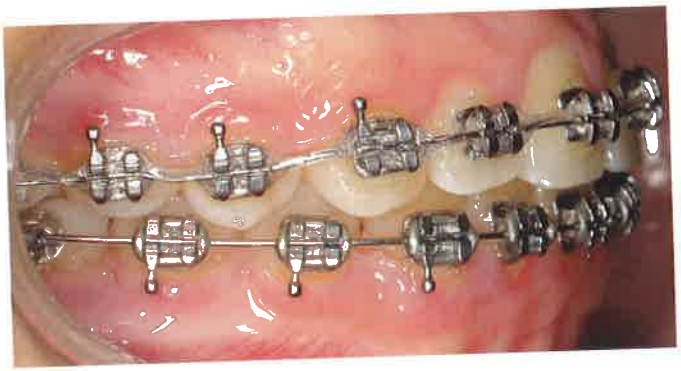


Fig. 2.69

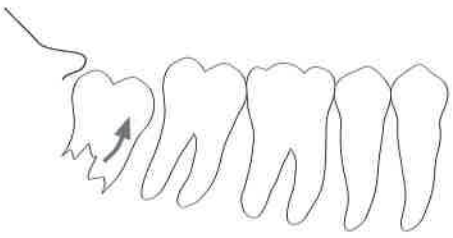


Fig. 2.72A

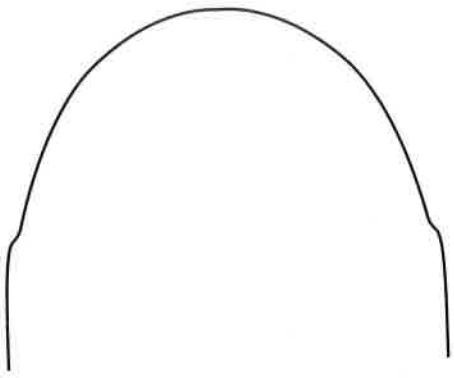


Fig. 2.72

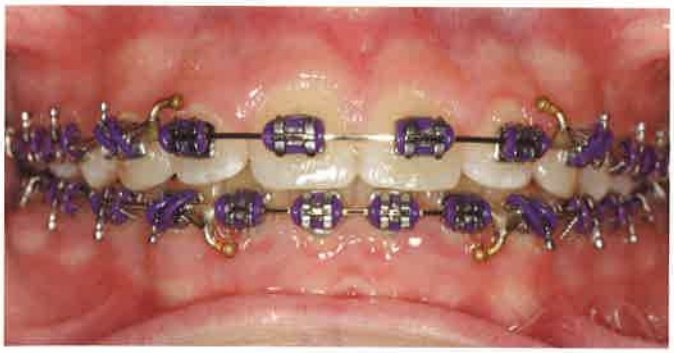


Fig. 2.64

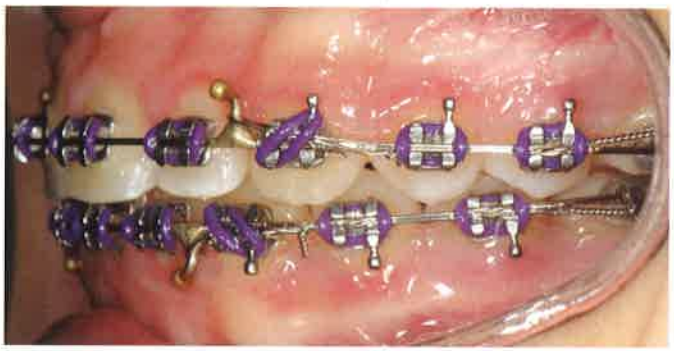


Fig. 2.65

Fig 2.68

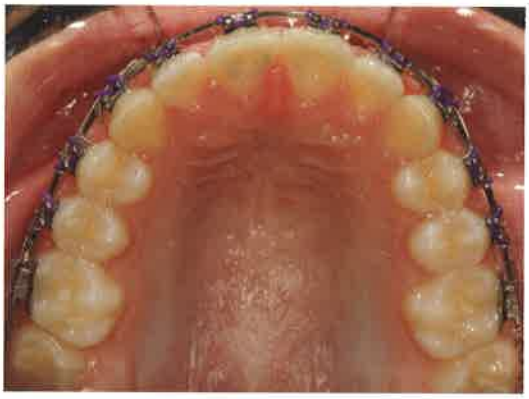


Fig. 2.67

Fig. 2.70

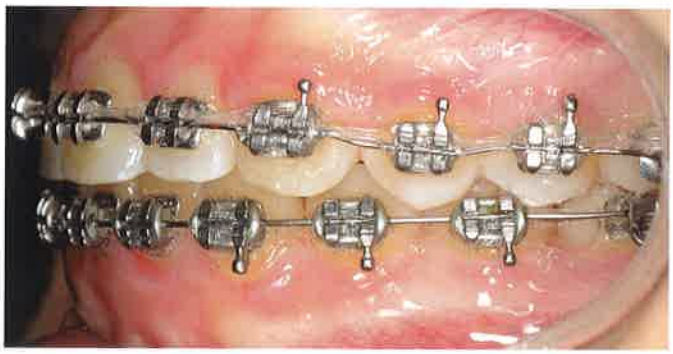


Fig. 2.71

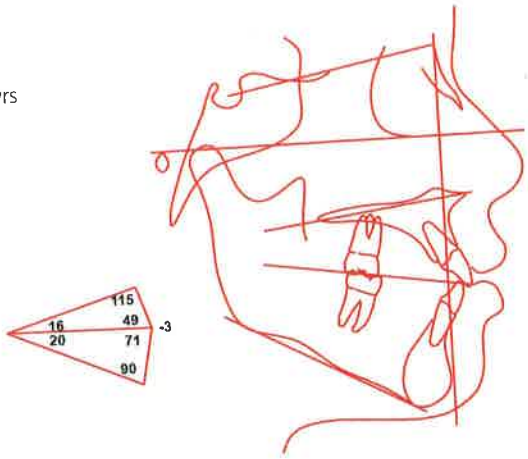
Fig. 2.73

Fig. 2.73i

Final records showed that a satisfactory facial pattern was maintained, with a pleasing final profile. A final Class I occlusion was obtained, with correction of the overbite and overjet. Lower anterior crowding was corrected, and a panoramic radiograph confirmed adequate root positioning. Third molars were developing well, and removal may be suggested, depending on the eruption pattern and root formation. If they remain asymptomatic, and irritation or infection is unlikely, then they can be maintained.

Final tracings show satisfactory conventional cranial base values, as well as adequate Arnett anterior segment values.

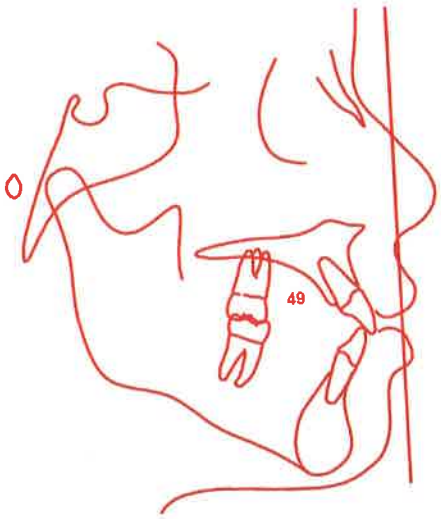
S.Z.
FINAL
12.9 yrs



SNA 81°
SNB 78°
ANB 3°
A-N ⊥ FH 1 mm
Po-N ⊥ FH -1 mm
WITS -3 mm
GoGn SN 34°
FM 27°
MM 35°
↑1 to APo 7 mm
↓1 to APo 4 mm
↑1 to Max Plane 115°
↓1 to Mand Plane 90°

Fig. 2.74

S.Z.
FINAL
12.9 yrs



↑ Incisor torque to occl. plane 49°
↑ Incisor tip to TVL -9 mm
↑ Lip thickness 14 mm
↑ Lip to TVL 4 mm

Max. anterior height 27 mm
↑ Lip length 22 mm
↑ Incisor exposure 5 mm
Inter-labial gap 4 mm

Occlusal plane to TVL 99°
↓ Incisor torque to occl. plane 70°
↓ Lip thickness 13 mm
↓ Lip to TVL 2 mm
Soft tissue 'B' point -5 mm
Soft tissue pogonion -7mm

Fig. 2.75

Fig. 2.76

Fig. 2.77

Fig. 2.78

Fig. 2.79

Fig. 2.80

Fig. 2.81

Fig. 2.82

Fig. 2.83

Fig. 2.84

The superimpositions show slight advancement of upper and lower incisors, as planned. The curve of Spee was leveled. This was mainly due to the eruption of the lower posterior segment as growth occurred.

S.Z.
BEG/FINAL
SN AT S

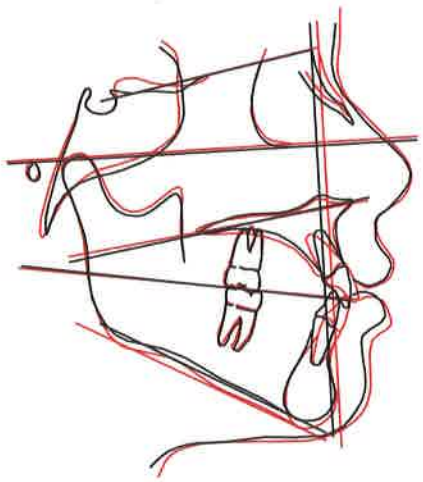
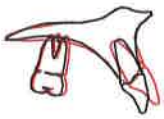


Fig. 2.85

S.Z.
BEG/FINAL

PALATAL PLANE AND
PALATAL CURVATURE



MAND SYMPHYSIS AND
MAND PLANE

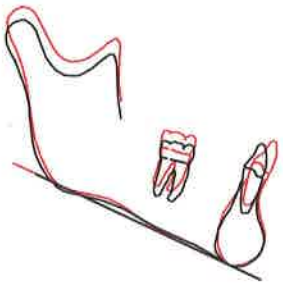


Fig. 2.86

CHAPTER 3

Orthodontic bracket design and tooth control

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Bracket design with adequate width	35
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Tie wing ligation	36
The use of gauges	37
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Orthodontic bracket design and tooth control

The system of orthodontic treatment described in this and two previous books has been developed over several decades. During that time there has been much trial and error with a wide range of different appliances. For the mechanics to be fully effective, only the best will do, and the following appliance features are required:

- The .022 slot size.
- The correct prescription and width (Chapter 4).
- The avoidance of needless size and complexity.
- Tie wing ligation.
- The ability to use of gauges.
- Strength and reliability.
- Accurate manufacture.
- A design which allows inversion

Recent appliance evolution

In recent years, appliance evolution has led to smaller brackets, different manufacturing processes, and the wider use of self ligating methods. All these changes tend to reduce tooth control, which is the main function of the appliance.

The original SWA brackets and the early MBT™ full size brackets provided excellent control (Fig. 3.01) and the authors treated many cases with them (B1 & B2). If a bracket is 20% smaller there will be 20% less tooth control, but despite this, in the late 1990s there were requests for smaller brackets, and mid-size or low profile brackets became the normal (Fig. 3.02).

Milling is regarded as an accurate manufacturing process, either creating the bracket and the slot with conventional milling machines, or using computer numerical control (CNC). However, the switch to mid-size brackets coincided with a move away from milling, and a change to metal injection moulding (MIM). Brackets manufactured in this way can be accurate, but expertise is needed, with good quality control, and many have been shown to be inaccurate [1,10].

During the 2000s there was increased availability of brackets with self ligating closure mechanisms (SLBs) (Fig. 3.03). Various SLB types were evaluated by the authors, but they did not work well with the recommended mechanics, and there was a switch back to milled tie wing brackets (Fig. 3.04) made by CNC.

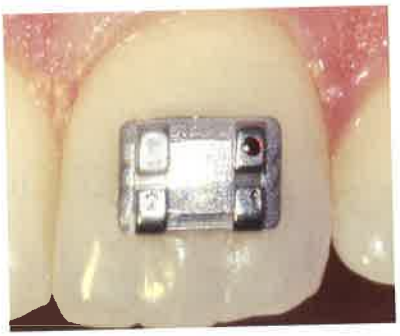

Fig. 3.01 The early MBT™ full size brackets were made by conventional milling and provided excellent tooth control.

Fig. 3.02 The switch to mid-size brackets coincided with a change to metal injection moulding (MIM) and less control.

Fig. 3.03 Narrow self ligating brackets have insufficient control to work well with the recommended mechanics.

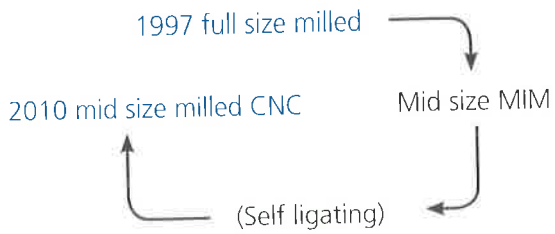

Fig. 3.04 The authors have evaluated many different appliance options. They tried midsize MIM and SLB bracket types, but they did not work well with their mechanics. They have gone 'full circle' and recommend accurate milled .022 slot brackets as the most effective for the treatment system.

Slot size

The larger .022 slot (Fig. 3.05) is more effective than the .018 slot with the recommended mechanics (B1 p. 13). At the start of treatment a lighter, more comfortable force is applied to the teeth, due to the greater movement of the wire in the .022 slot, and a light force is correct at this early stage, while osteoblasts and osteoclasts assemble. In mid treatment the .019 / .025 working wire can be used, for good overbite control. Finally, during settling, light wires have slightly more vertical movement (B1 p. 13).

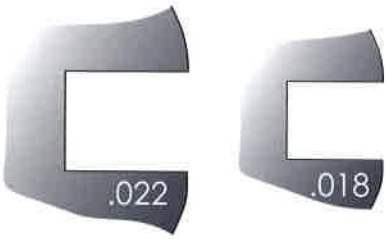

Fig. 3.05 The .022 slot continues to be recommended in preference to the smaller .018.

Brackets designed with adequate width

The prescription needs to be fully expressed during treatment, and for this, the appliance has to be accurately manufactured, have sufficient width (Fig. 3.06) and be accurately bonded .

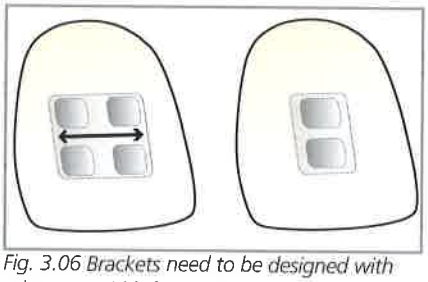

Fig. 3.06 Brackets need to be designed with adequate width for rotation and tip control. Narrow twin brackets or single wing brackets do not work well with the recommended mechanics.

Narrow, single wing brackets (Fig. 3.07) were evaluated by the authors and a case was published (B1 p. 79). They were good for patient comfort, and effective for simple cases, but were not a good design for more difficult malocclusions. Wider is better when it comes to rotation and tip control, and minimal widths are discussed in the next chapter (Fig 4.11 Page 45).

Fig. 3.07 Single wing brackets, whether self ligating or tie wing type, provide less rotation and tip control when compared with twin brackets of correct width.

Size and complexity

Compact size and lack of complexity are important design requirements. Small brackets reduce the volume of foreign material in the mouth, which is cleaner and more comfortable for the patient. They cause fewer interferences, which reduces the risk of bond failures, and if a small bracket (Fig. 3.08) can deliver proper control it will be a better design than a bulky, higher profile bracket of the same performance (Fig. 3.09).

Fig. 3.08 Small brackets reduce the volume of foreign material in the mouth, which is cleaner and more comfortable for the patient, causing fewer interferences.

Fig. 3.09 Unduly complex brackets are more difficult to keep clean, more liable to breakage, and cause more interferences. They are not recommended.

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Tie wing ligation

A conventional 'tie-wing' edgewise bracket relies on a ligature wire or an elastomeric module to hold the archwire in place, and there is some versatility (Fig. 3.11). The wire can be held by a module, a ligature, or a loose ligature. It has been shown that a loose ligature offers great ease of sliding, and less friction than any of the self ligating mechanisms [2].

In contrast, 'self-ligating' brackets (SLBs) are designed to retain the archwire in the slot without the use of a ligature wire or a module. They generally fall into three categories, which have 'closed box', 'spring clip', or 'jaws' mechanisms (Figs. 3.10 & 3.12) but there are numerous individual differences and modifications.

The authors evaluated several self ligating bracket types. They found that early unravelling occurred [8] but often with unwanted expansion [3] and that tooth control was a problem later in the treatment. There were other difficulties, and patients reported discomfort during wire removal with some types [4]. Tie wing brackets continue to be recommended for these reasons.

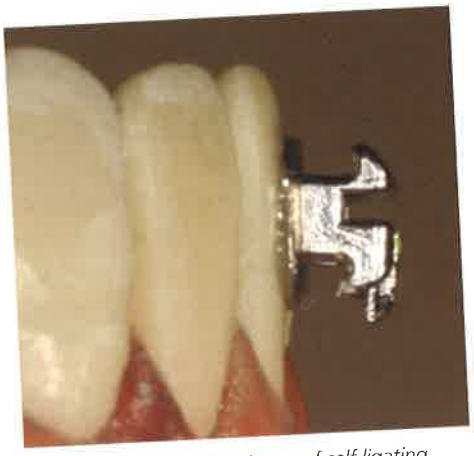

Fig. 3.10 The 'closed box' type of self ligating bracket. After evaluation, the authors have found that SLBs are not the best bracket choice for use with their mechanics.

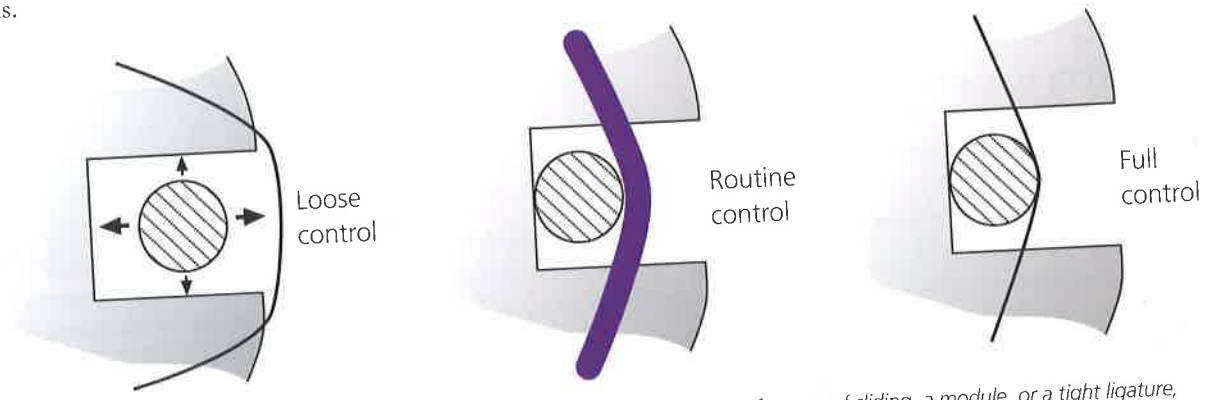

Fig. 3.11 Tie wing brackets offer versatility. The wire can be held by a loose ligature for ease of sliding, a module, or a tight ligature, depending on the needs of the case and the stage of treatment.

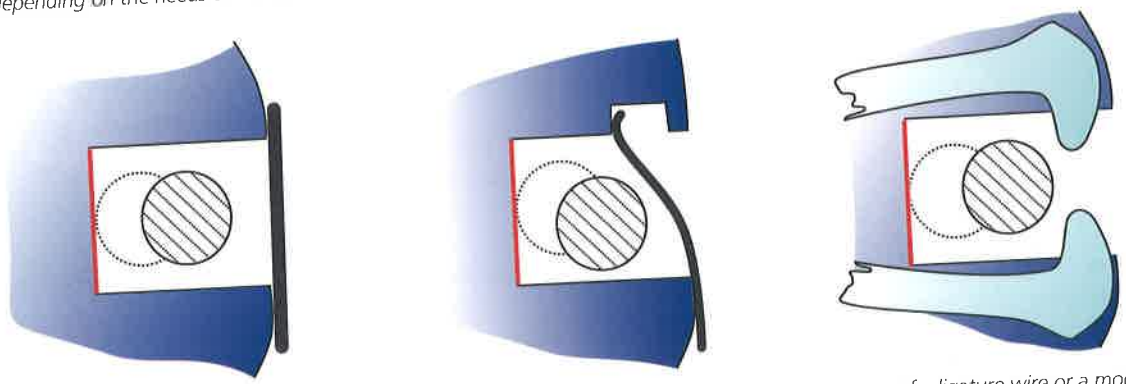

Fig. 3.12 Self-ligating brackets (SLBs) are designed to retain the archwire in the slot without the use of a ligature wire or a module. The three main categories are 'closed box', 'spring clip', or 'jaws' but there are many differences and modifications.

The use of gauges

Gauges are essential for accurate vertical positioning of brackets and tubes, whether using direct or indirect bonding (Chapter 6). They can be easily and accurately used with conventional tie-wing brackets, but the design of most self-ligating brackets makes it difficult or impossible to use them (Fig. 3.13). The closure mechanisms of SLBs normally prevent the use of gauges when closed, and can interfere when in the open position.

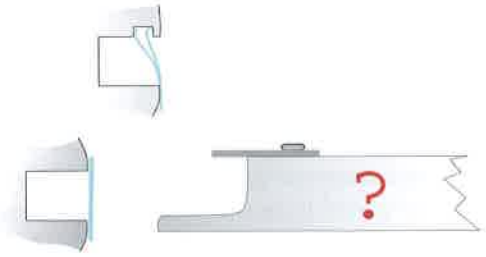

Fig. 3.13 The design of self-ligating brackets makes it difficult or impossible to use gauges for vertical positioning.

Strength and reliability

If a bracket breaks or does not function properly, or if the bonding fails, treatment efficiency is reduced. Extra doctor time is needed for repairs, and often teeth will move and require re-levelling and aligning. To avoid these problems, appliances need to be designed for strength and durability, and tie wing brackets are very reliable in these areas.

Some self-ligating closure mechanisms can malfunction, break, or clog up with food or calculus and will tend to have a greater chance of bond failure because of their size and prominence (Fig. 3.14).

Fig. 3.14 Some self-ligating closure mechanisms can malfunction, break, or clog up with food or calculus

Accurate manufacture

Historically, most orthodontic brackets have been manufactured with an oversize slot, to allow easier of insertion and removal of archwires. However, a published study of the slot dimensions of various brackets revealed that some well-known brands were substantially oversize [1]. For good torque control the sides of the slot should be parallel and the dimension of the slot has to be very close to .022, otherwise a serious falling-off in torque control occurs (Fig. 3.15).

Fig. 3.15 Oversize slots undermine the whole basis of preadjusted edgewise. Slots at .023 or .024 increase the work of the orthodontist, because tedious wire bending will be needed for torque control and finishing.

Oversize slots undermine the whole basis of preadjusted edgewise, which is intended to minimize wire bending. The treatment method relies on control using .019 / .025 working wires in an accurate .022 slot. Inaccurate slots at .023 or .024 increase the work of the orthodontist [9], because tedious wire bending will be needed for torque control and finishing (Fig. 3.15).

During manufacture, checks need to be in place to ensure the sides of the slot are parallel, the slot size is accurate, and that other errors do not occur (Fig. 3.16). In this way the brackets and tubes should be accurate, and the appliance will be exactly as claimed in the brochure.

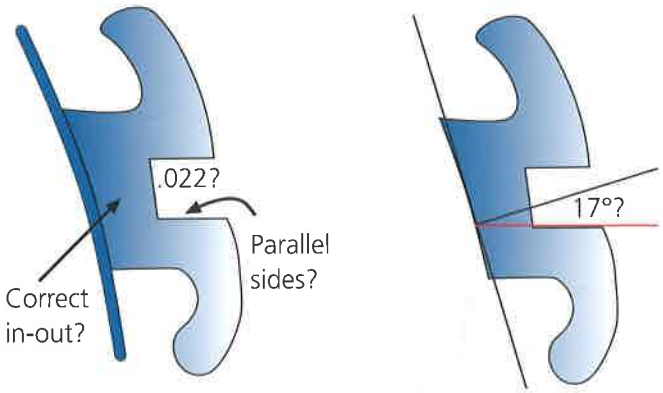

Fig. 3.16 Brackets should be manufactured to ensure the sides of the slot are parallel, the slot size is accurate, and that other errors do not occur.

Bracket inversion

Conventional tie-wing edgewise brackets work well when they are inverted, and this reduces wire bending in many cases, as discussed in chapter five (Fig. 3.17). However, bracket inversion is not an option with many self-ligating designs because of interference difficulties and the risk that biting forces may open the closure mechanism, causing release of the archwire.

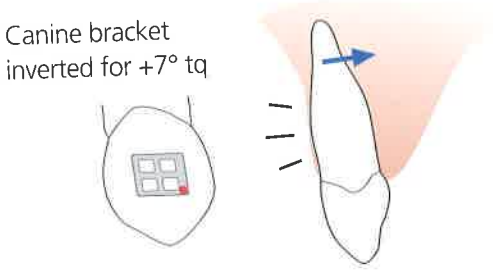

Fig. 3.17 Conventional tie-wing edgewise brackets work well if they are inverted, and this reduces the need for wire bending in many cases. Bracket inversion is not an option with many self-ligating designs.

Bracket hooks

Integral bracket hooks became an option in the 1970s, with the arrival of the preadjusted appliance, and they are now widely available as an option on premolar and canine brackets (Fig. 3.18). There are differences of opinion. Some orthodontists feel hooks are essential on all cases for proper treatment mechanics, particularly up-and-down elastics at the end of treatment. Others believe they are serious plaque traps and cause needless discomfort to the patient for the duration of the treatment, although they may only be used for a few weeks or not at all (Fig. 3.19).

The authors chose not to use hooks as they developed their technique, and their published cases (B2 and B3) were successfully treated without hooks. For these treatments Kobyashi ties or other mechanisms were added for a short period, if needed. This was a cleaner, more comfortable experience for the patient than having hooks in the mouth for 18 to 24 months.

This book has cases with bracket hooks, because the authors have been evaluating this option. One author (RPM) now prefers to have hooks on canine brackets, but not premolars. The other author (JB) has reverted to having no hooks.

Fig. 3.18 It is more comfortable for the patient to avoid the use of brackets with built-in hooks. Kobyashi ties or other mechanisms can be quickly and easily added if needed during finishing. Brackets without hooks provide a cleaner, more comfortable experience for the patient.

Checking for accuracy

It is possible to examine the slot size using magnifying lens and a wire of exactly .021 / .025 dimension (Fig. 3.20). In an accurate bracket it will move no more than about 3 or 4 degrees, depending on the 'rounding' of the wire edges.

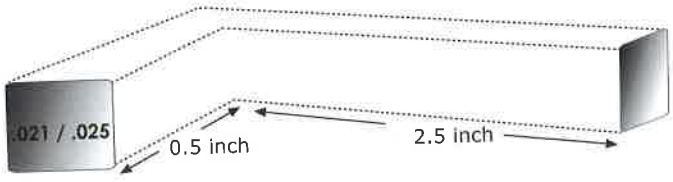

Fig. 3.20 A wire of exactly .021 / .025 dimension can be used to check the slot size. In an accurate bracket it will move no more than about 3 or 4 degrees.

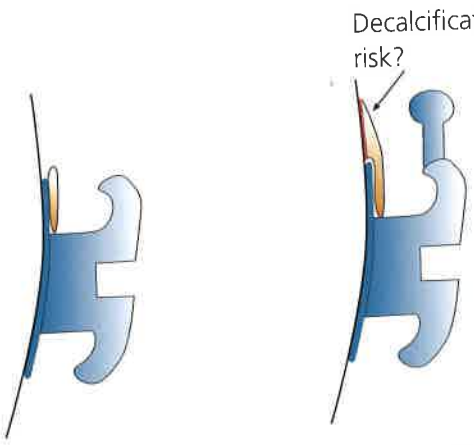

Fig. 3.19 Hooks are uncomfortable for the patient and bring an added risk of decalcification due to plaque accumulation at the gingival margin.

Friction? What friction?

There are some unresolved issues in orthodontics, but friction is not one of them. The literature provides little evidence for the notion that lack of friction is important in bracket design, or 'friction-free' ligation brings any benefit to the patient or the orthodontist.

Most friction studies have been in laboratory conditions, and these bench tests have been misleading. When the dynamics of the oral cavity are simulated, friction is not an issue, because the oral cavity is lubricated by saliva and is an area of intense activity [5,6,7].

A study by Braun and co-workers noted 'minute movements occur many thousands of times a day at the bracket/arch wire interfaces and that friction during sliding mechanics is 'effectively reduced to zero' each time such movements occur [5]. It concluded 'Factors such as the degree of dental tipping, relative arch wire/slot clearances, and method of ligating did not have a measurable effect on frictional resistance in the simulated dynamics of the oral environment.'

O'Reilly and co-workers [6] concluded that when the dynamics of the oral environment were simulated, any resistance to sliding mechanics reduced by up to 85%. Later, in 2007, Swartz [7] conceded that laboratory testing 'may have resulted in an overestimation of the clinical significance of friction'.

It has been shown that almost friction-free mechanics can be achieved using loosely tied tie-wing brackets and there is less friction than with self-ligating brackets [2]. Loose ligation (Fig. 3.21) will assist in rapid alignment at the start of treatment, if the case needs this, and later in treatment modules or wire ligatures are used for optimal control and full expression of the bracket specification.

Using sliding mechanics, with correct force levels, extraction space normally closes at 1.0 mm to 1.5 mm per month (Figs. 3.22, 3.23 and 3.24). The limiting factor is cell biology, and there is considerable individual variation (B4).

Known obstacles to space closure include inadequate levelling, damaged brackets, incorrect force levels and interference from opposing teeth. These have been reviewed previously (B2 p.259).

Fig. 3.21 Almost friction-free mechanics are possible with loosely tied tie-wing brackets and there is less friction than with SLBs.

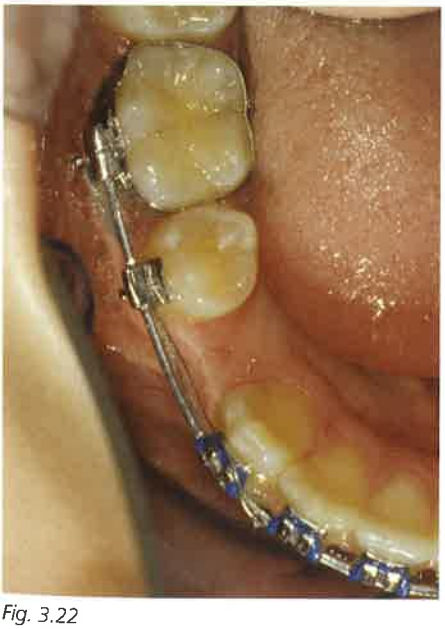

Fig. 3.22

Fig. 3.23

Fig. 3.24

Figs. 3.22, 3.23 & 3.24 This sequence shows the use of active tiebacks for closure of lower premolar space in a typical case. At monthly checks the arch wire will be seen to protrude from the molar tube by 1.0 mm to 1.5 mm, indicating satisfactory progress. In the majority of cases space closure is achieved uneventfully, with few problems. After completion of space closure, passive tiebacks are used to prevent space from reopening.

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CHAPTER 4

Recommended brackets and tubes

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Recommended brackets and tubes

or good orthodontic results, there is a need to control tip, n-out, rotations, and torque. Good control depends mainly n the brackets, but other factors play a part, including bracket ositioning (page 66), wire selection (page 91) and force levels.

The size and production of metal brackets

The authors used standard or 'full-size' milled metal brackets (Fig. 4.01) for several years from 1996 and they provided excellent control. They published many cases featuring them (B2 & B3).

During the 2000s there was a gradual move into smaller, mid-size metal brackets, made in a different way (Fig. 4.02). They were not milled, but were manufactured by metal injection molding (MIM). This was an efficient process, but the molds were expensive, and changes, when desired, were costly. The metal shrank as it cooled, and to avoid reducing slot sizes below .022 or .018, larger tolerances were introduced. This resulted in inaccuracies in bracket slots, particularly in the torque dimension. Eventually, in 2009 the authors switched back to precise milled brackets, this time made by computer numerical control (CNC) for more accurate .022 and .018 slots. The metal brackets and tubes described in this chapter are made by this method.

The recommended prescriptions for control of tip, in-out, rotations, and torque are shown in the following pages. These are unchanged since they were announced by the authors in 1997 (B2). It is important to use accurate brackets, as it has been shown that there were widespread shortcomings in the past [1].

Aesthetic brackets

Most orthodontists offer an aesthetic bracket, at least for the upper anterior teeth, and these are available with or without metal slots (Figs. 4.03 & 4.04). The authors use the type without metal slots, manufactured to an accurate specification. The metal slots were previously advocated for strength and because of the risk of wire notching. The newer ceramic brackets are stronger, and notching has not proved to be a problem, especially in the anterior region where minimal sliding occurs.

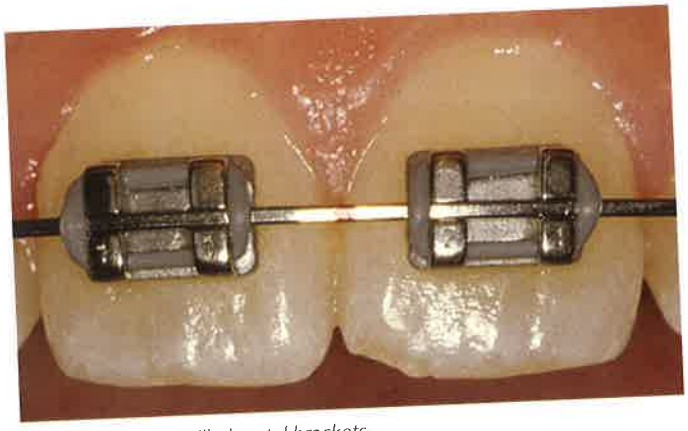


Fig. 4.01 Full-size milled metal brackets.

Fig. 4.02 Mid-size (MIM) metal brackets.

Fig. 4.03 Aesthetic brackets with metal slots.

Fig. 4.04 Aesthetic brackets without metal slots.

Control of tip (i.e. angulation)

Tip (or angulation) was defined by Dr. Lawrence Andrews [2,3] as the angle formed by the facial axis (i.e. the long axis) of the clinical crown and a line perpendicular to the occlusal plane (Fig. 4.05). This definition applied to all incisors, canines and premolars. Tip is well controlled by preadjusted edgewise brackets, and the bracket specifications are almost fully expressed in most cases. Therefore, there are no significant changes in the tip dimension between our previous appliance and our present Avex™ appliance. The authors' 1997 values for tip (B2) were based closely on Andrews' research figures, but with minor changes for molars and upper premolars (Fig. 4.06).

For all molars, a 0° tip tube is recommended (B2 p. 283). When these tubes are placed parallel to the buccal cusps of the molars, the 0° tip attachment delivers the research figures of 5° tip for the uppers and 2° tip for the lowers (Fig. 4.07). Andrews used the buccal groove as a reference for the long axis of molars [2,3].

For upper premolar brackets, 0° of tip is recommended compared with 2° in the original SWA, which helps to place the crowns of these teeth more in a Class I direction. The total of 8° less tip in the four upper premolars, compared with the SWA, helps reduce the anchorage needs in some Class II cases in the upper arch.

For good tip control all brackets and tubes need to be sufficiently wide (Fig. 4.11). If a bracket is too narrow, or a molar tube is too small in the mesio-distal dimension, it may be difficult to get good tip control. An oversize slot will slightly undermine good tip performance [4].

Along with top quality brackets, accurate axial positioning is essential to ensure correct tip (page 68).

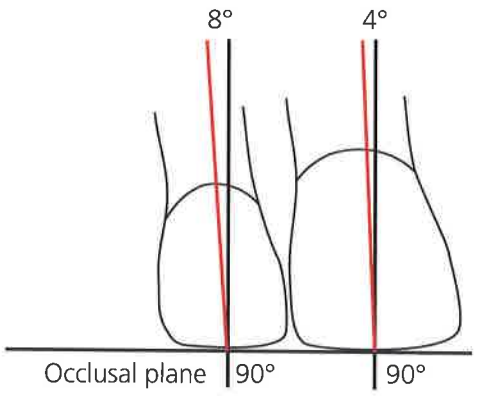


Fig. 4.05 Tip (or angulation) was defined by Andrews as the angle formed by the facial axis of the clinical crown, shown here in red, and a line perpendicular to the occlusal plane. This definition applied to all incisors, canines and premolars. The appliance is crown related, so tip and torque are not determined by the roots of teeth.

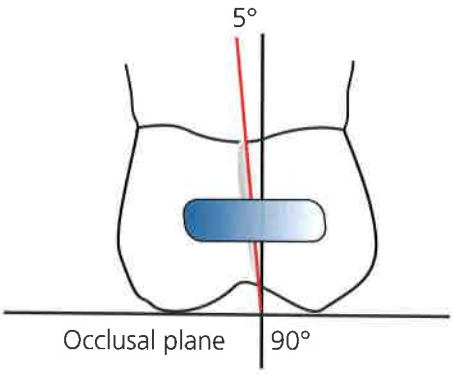


Fig. 4.07 Andrews defined molar tip using the angle between the buccal groove and a line perpendicular to the occlusal plane. The average was 5° for the upper molars and 2° for the lowers. When tubes with 0° tip are placed parallel to the buccal cusps of molars, they deliver the correct tip.

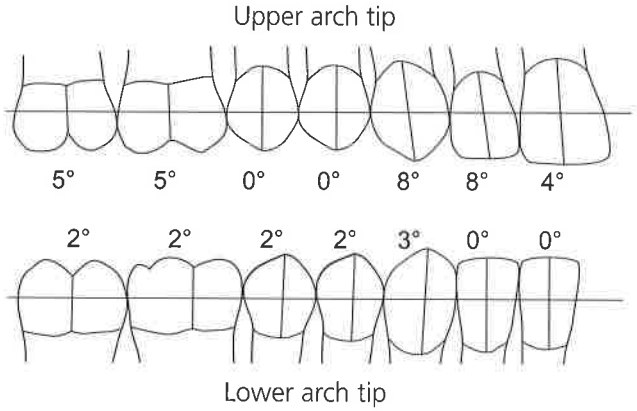


Fig. 4.06 The authors' 1997 values for tip were based closely on Andrews' research figures, but with minor changes for molars and upper premolars. The same values continue to be recommended in the Avex™ appliance.

Control of in-out

Andrews used the term 'prominence' to describe what is commonly known as 'in-out', and he measured it from a line known as the 'embrasure line' (Fig. 4.08). This was defined as 'an imaginary line, at the level of the crown's mid-transverse plane, that would connect the most facial portions of the contact areas of all crowns in an arch when they are optimally positioned'[3]. He used this concept in developing the original SWA, but these in-out values changed with appliance development over the years. Metal brackets moved from full size to mid-size to low profile. As the incisor brackets were made thinner, it was difficult to make the canine brackets thin enough, and there was often too much in-out in the canine brackets.

Aesthetic brackets went through a phase where fracturing was common. The next generation of aesthetic brackets were made larger for greater strength. The canine brackets, in particular, were made proportionately too large which created too much in-out with these teeth. Finally, self-ligating brackets required certain in-out values for the inclusion of clips and gates. Therefore, the in-out figures were modified to appropriately accommodate the self-ligating mechanisms, and errors were introduced.

As a further factor in control of in-out, the bracket closure mechanism has to hold the arch wire firmly against the base of the slot. Otherwise, when using light wires in the finishing stages, the tooth can move buccally or lingually into an incorrect in-out position (Fig. 4.09). Finally, vertical accuracy is needed when bonding[5]. Errors can place the brackets in the wrong thickness part of the crown, and have a small influence on in-out, especially with curved teeth such as canines.

Upper second premolar in-out

In the 1990s an alternative upper premolar bracket was tried. It was 0.5mm thicker than the research value, and intended for use with small upper second premolars, as may be seen in up to 20% of cases (B3 p. 52). This is no longer used, as the stock control difficulties outweighed any advantages, and it was more prone to bond failure, due to its thickness. For cases with small upper second premolar crowns, the authors prefer to make minor finishing bends.

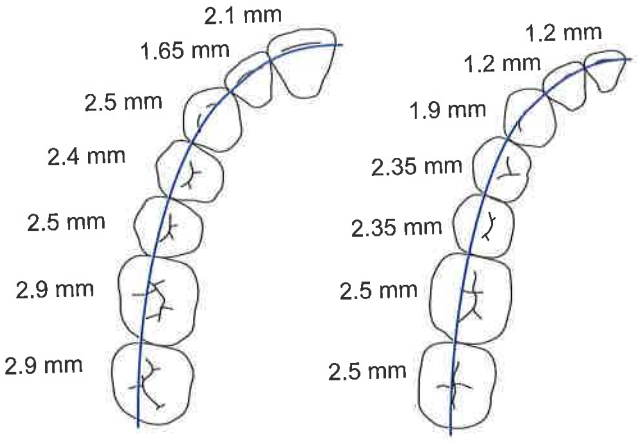


Fig. 4.08 Andrews used the term 'prominence' to describe what is commonly known as 'in-out'. He measured it from an imaginary line known as the 'embrasure line', shown here in blue for the upper and lower arches. Redrawn from Dr. Andrews' book (Ref. 3 p. 32 & 33).

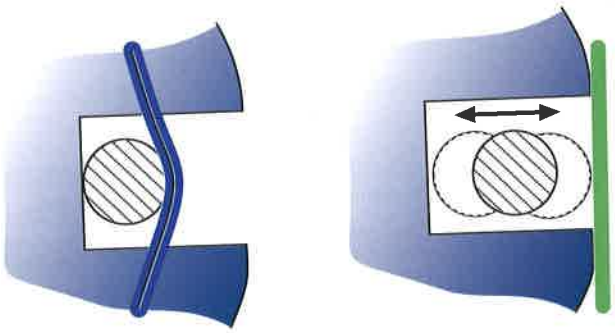


Fig. 4.09 For good in-out control, the bracket closure mechanism has to hold the arch wire firmly against the base of the slot. Tie wing brackets are more effective than self ligating brackets for this.

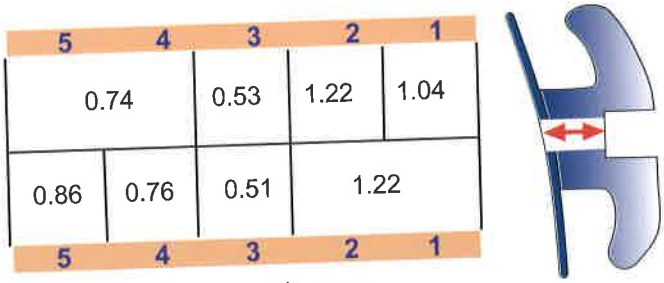


Fig. 4.10 For good in-out control the recommended 'prominence' values, based largely on Andrews' research, need to be precisely built into the bracket system during manufacture. Here the recommended values are expressed in millimeters.

Control of rotations

Andrews' fourth key to optimal occlusion was 'an absence of rotations'[3 p.22]. To achieve good control of rotations the brackets need to have adequate width (Fig. 4.11) because narrow brackets are less effective than wider brackets [4]. They should be bonded in a correct mesio-distal position (page 67) and have a bracket closure mechanism which holds the arch wire firmly against the base of the slot (page 36). Tie wing brackets are more effective than self ligating brackets at rotation control.

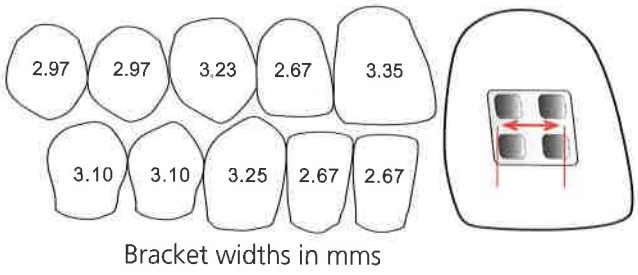


Fig. 4.11 Narrow brackets do not adequately control rotations and brackets need to have adequate width.

Control of torque (i.e. inclination)

The term 'inclination' was used by Andrews to describe what is commonly known as 'torque' (Fig 04.12). He defined it as 'the angle between a line perpendicular to the occlusal plane and a line that is parallel and tangent to the FACC at its midpoint'[3 p.15].

Torque is not well expressed by the preadjusted appliance, because (1) the area of torque application is small compared with the bulk of the tooth and (2) the .019/.025 wire does not fill the .022 slot. Accordingly, the authors' 1997 values (B2) provided for extra torque control in the incisor, molar, and lower premolar brackets compared with the research figures (Fig. 4.13).

Clinical goals can be reached with a minimum of wire bending, provided these torque values are used and the slot and tube manufacture is accurate. As discussed in the previous chapter and above, an oversize slot or tube undermines torque control, and MIM bracket slots are often larger than the .022 and .018 dimensions. Additionally, the base of the slot needs to be close to the tooth surface, because torque expression becomes less effective with thicker brackets.

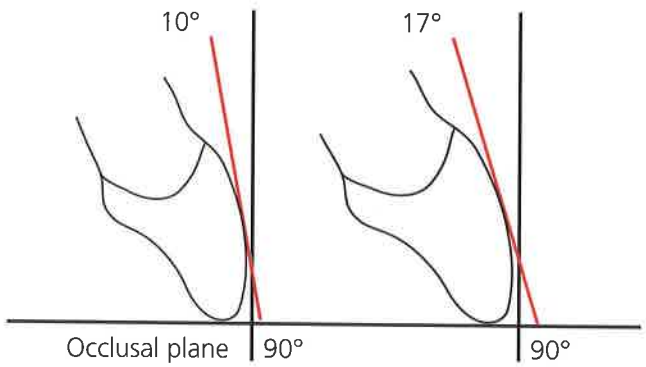
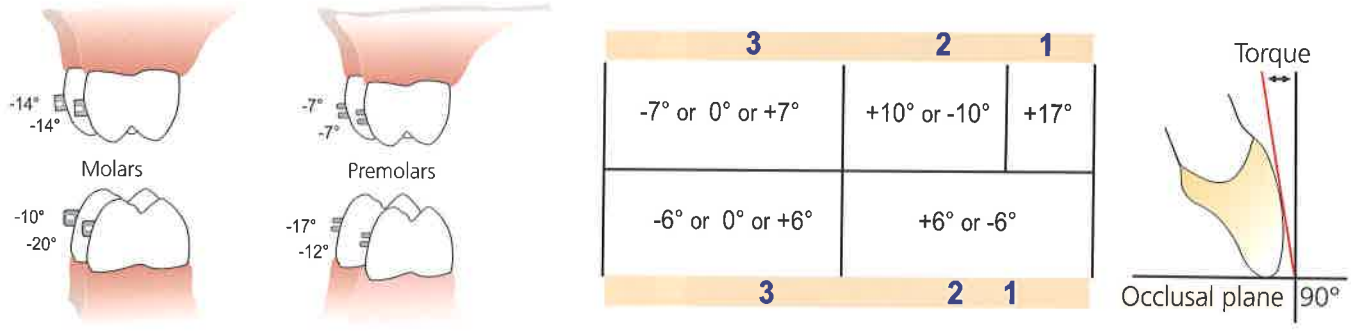


Fig. 4.12 Andrews defined torque (inclination) as 'the angle between a line perpendicular to the occlusal plane and a line that is parallel and tangent to the FACC at its midpoint'. Values for upper central and lateral incisors are shown here. Torque is not well expressed by the preadjusted appliance.



igs. 4.13 The authors' 1997 values for torque were based on Andrews' research findings, and continue to be recommended. They included extra torque ontrol compared with the research values, because torque is not well expressed by the preadjusted appliance, and a .019 / .025 working wire does not ill the .022 slot. More information is given on pages 46, 47, 57, & 58.

Incisor torque control

There is 10° of play between the .0195 / .025 wire and the .022 slot in the torque dimension, and for this reason it is recommended to have +17° torque for the upper central incisors, +10° for the upper lateral incisors, and -6° for all the lower incisors (Figs. 4.14 to 4.16). These values meet the need for extra palatal root torque for the upper incisors and more labial root torque control for the lower incisors, compared with the research figures (B2 p. 47, 48). They have worked well for the authors for 17 years.

The recommended incisor torque values help in the following malocclusions:

- Class I treatment, where correct incisor torque helps to achieve good anterior tooth fit.
- Class II treatment, because Class II elastics can cause upper incisor torque to be 'lost', and lower incisors tend to procline during levelling or in response to Class II elastics.
- Class III treatment, where the anterior torque compensation helps in cases with Class III dental bases.

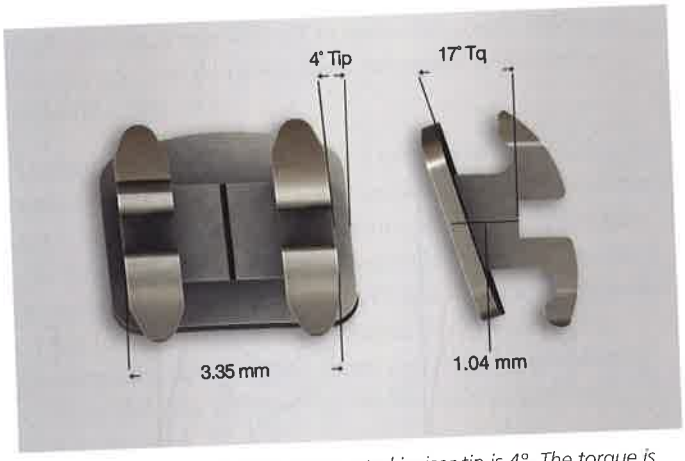


Fig. 4.14 The recommended upper central incisor tip is 4°. The torque is +17° which meets the need for extra palatal root torque compared with the research figures. The in-out is 1.04 mm and the width is 3.35 mm

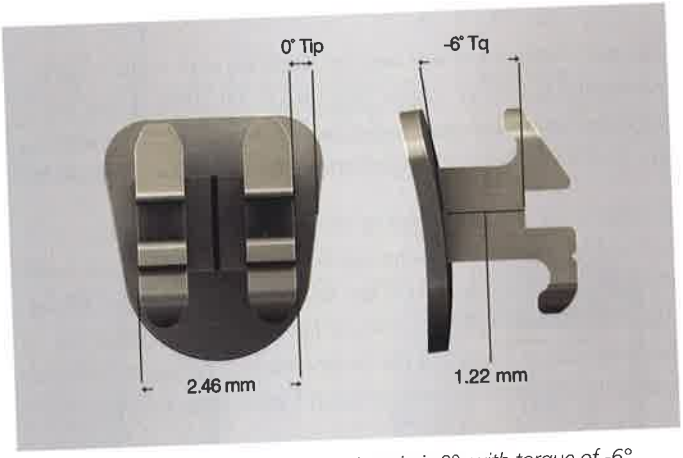


Fig. 4.16 The recommended lower incisor tip is 0°, with torque of -6° and width of 2.67mm. The in-out of 1.22 mm is based on the research findings, and this dimension is needed to avoid wire bending in the final stages of treatment.

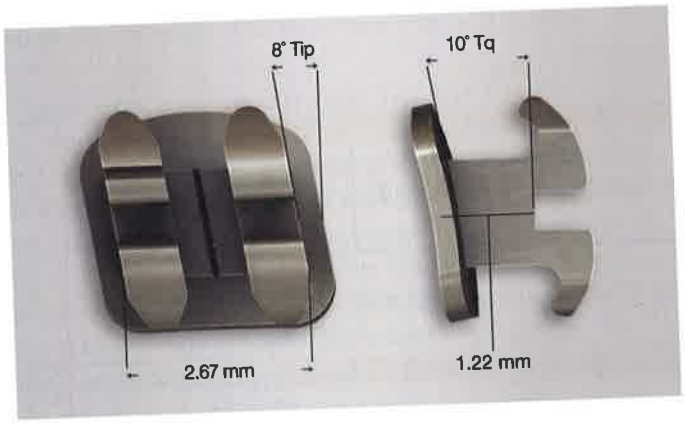


Fig. 4.15 The recommended upper lateral incisor tip is 8°, and the torque is +10°. The in-out is 1.22 mm and the width is 2.67mm. This bracket can be inverted in cases with instanding upper lateral incisors (page 57).

Three options for canine torque control

For the SWA appliance, Andrews used –7° torque for the upper canines and –11° torque for the lower canines. However, these values were based on the research figures from 120 non-extraction adult cases. They presumably had broad arches, so this was a different sample compared with a normal orthodontic caseload. In clinical practice, although the –7° upper canine torque is satisfactory for many cases, the value of –11° torque for the lower canines often leaves the roots in a prominent position.

The authors continue to use three torque options for upper and lower canines (Fig. 4.17). These are –7°, 0° and +7° torque for the upper canines and –6°, 0° and +6° for lower canines, as previously recommended (B2 p. 164). The torque options are shown (Figs. 4.18 - 4.21) and the clinical applications of these are discussed in the next chapter.

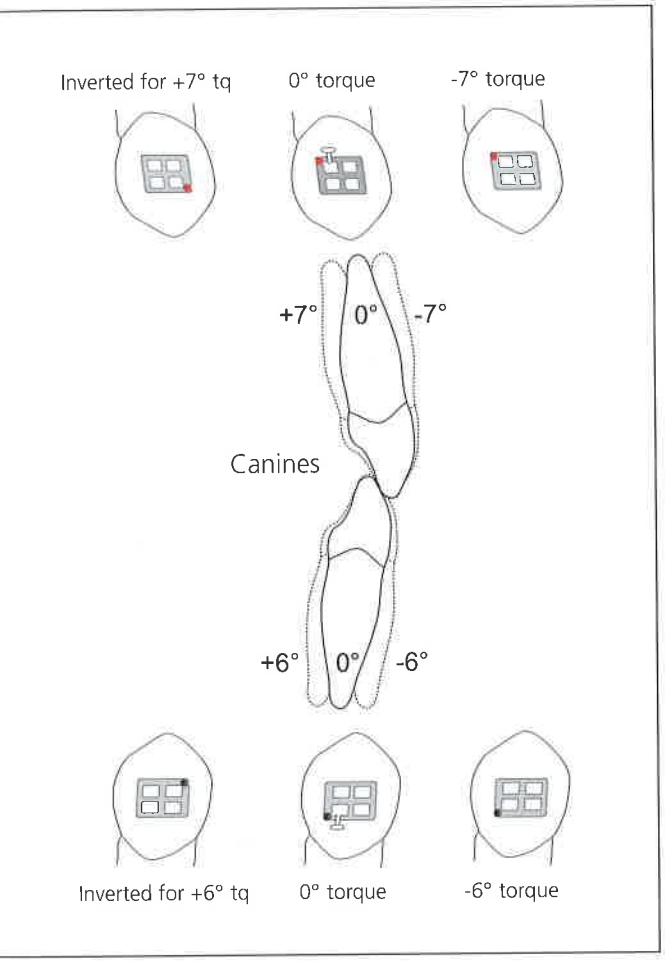


Fig. 4.17 It is helpful to have three torque possibilities for upper and lower canines, and the clinical applications of these are discussed in the next chapter.

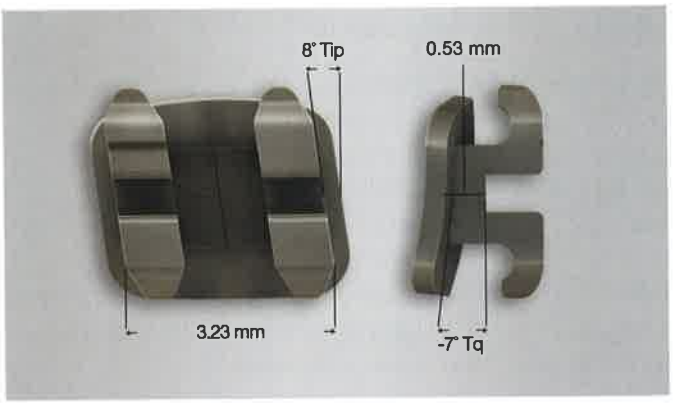


Fig. 4.18 The -7° torque upper canine bracket, shown here with no hook, is used if extra labial root torque is required. If inverted, it provides the option of +7° torque and additional palatal root torque. If using this bracket with a hook it is necessary to cut off the hook before inversion.

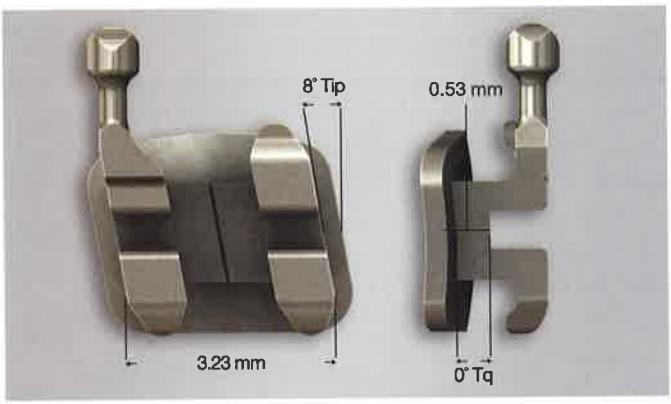


Fig. 4.19 The upper canine bracket has 8° of tip, in-out is 0.53 mm, and width is 3.23 mm, as for all upper canine brackets. The bracket shown here has 0° torque, which many orthodontists prefer for extraction cases (this keeps the root away from the cortical plate during retractions).

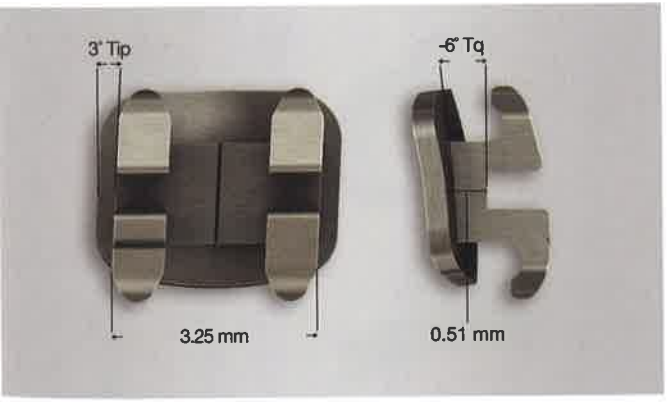


Fig. 4.20 The lower canine bracket with -6° torque, shown here with no hook, is used if extra labial root torque is needed. If inverted, it gives the option of +6° torque, for additional lingual root torque. If using this bracket with a hook it is necessary to cut off the hook before inversion.

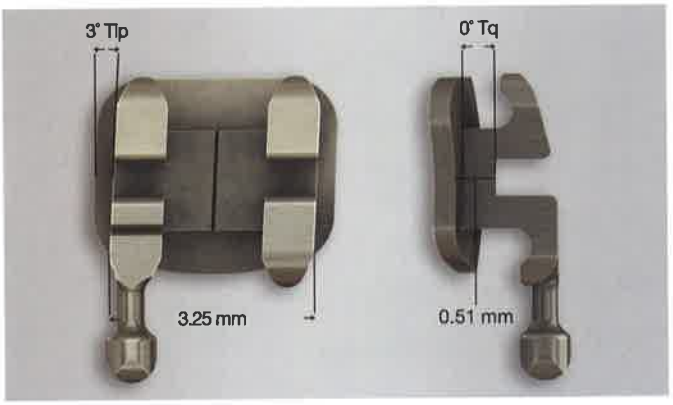


Fig. 4.21 The lower canine bracket has 3° of tip, in-out of 0.51 mm, and width of 3.25 mm, as for all lower canine brackets. The 0° torque lower canine bracket, shown here with a hook, is suitable for many cases, but -6° and +6° options are sometimes needed.

Upper premolar torque

The authors continue to recommend upper premolar torque of –7° which is based on the research value and works well in clinical use (Fig. 4.22). As previously noted, the upper premolar brackets have 0° of tip (compared with 2° in the original SWA). The reduced tip helps to position the crowns of these teeth more in the direction of Class 1, and slightly reduces anchorage needs in some cases. The 0° tip also allows versatility, because the upper premolar bracket can be used for left and right, first and second premolars.

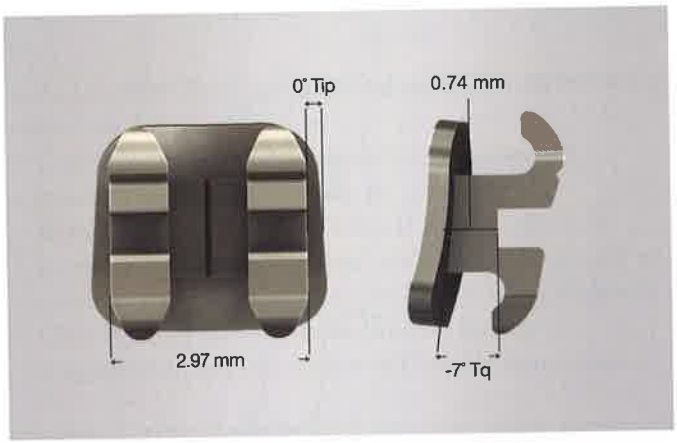


Fig. 4.22 The upper premolar bracket has 0° of tip, -7° of torque, and is shown here with no hook, which is recommended. The in-out is 0.74 mm and the width is 2.97 mm. The same bracket is interchangeable between left and right, and first and second premolars.

Upper molar torque

The –14° torque value for the upper molars gives good control of palatal cusps in most cases and continues to be recommended (Figs. 4.23 – 4.25). This compares with the SWA value of –9°. The extra control helps prevent the palatal cusps from hanging down, which in turn reduces interferences during mastication. A value of –19° for upper second molars has been evaluated, especially for use with mini tubes, because the palatal cusps of these teeth are a frequent source of interference in lateral excursions. However, with accurate tubes and careful mechanics, the –14° value works well for upper second molars, and continues to be recommended.

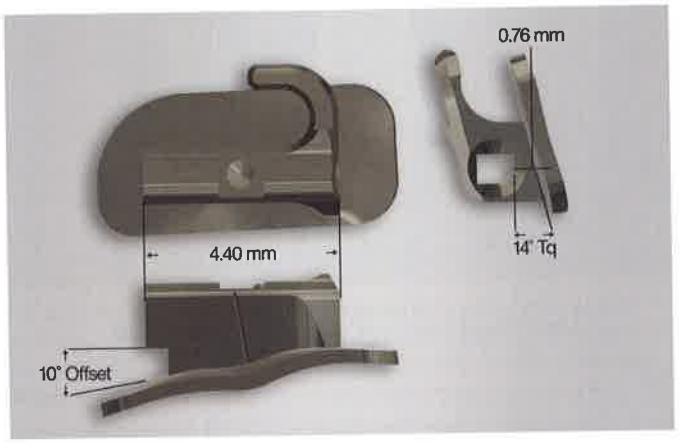


Fig. 4.24 Upper first molar tubes have 0° of tip, -14° of torque, and 10° of offset. The 0° tip delivers the correct tip of 5° when bonded correctly (Fig. 4.07). The mesio-distal dimension is 4.40 mm.

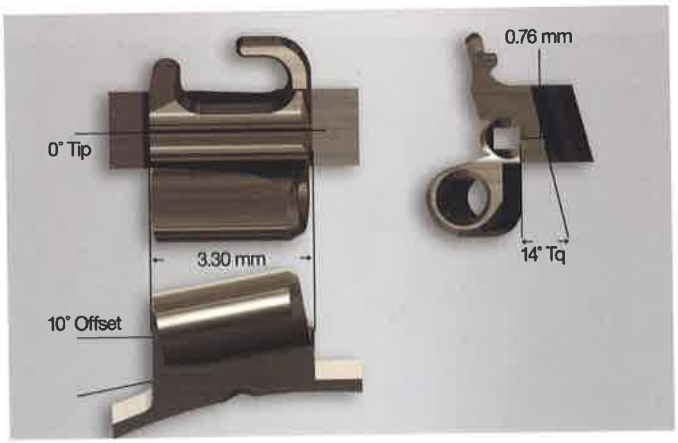


Fig. 4.23 The upper first molar attachment with a headgear tube has the same 0° tip, -14° torque and 10° of offset. The mesio-distal dimension is 3.30 mm. The headgear tube is used for a headgear or a Class II corrector.

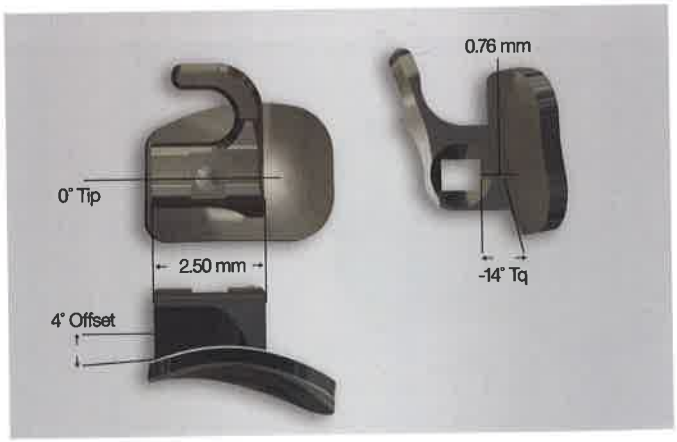


Fig. 4.25 Upper second molar tube has 0° of tip, and -14° of torque. The 4° of offset is less than the 10° for the first molar, due to its different bonding position, on the mesio-buccal cusp. The mesio-distal width is 2.50 mm.

Lower premolar and molar torque

The lower torque values (Figs. 4.26 to 4.29) are first premolar –12°, second premolar –17°, first molar –20°, and second molar –10° (B2 p.193, 258, 284 & 315). These differ considerably from the SWA specifications and help to prevent 'rolling-in' of lower molars. Buccal crown torque (uprighting) of the lower molars and premolars is normally beneficial in cases with narrow maxillary arches.

Bondable mini second molar tubes (Fig. 4.29) were introduced for teeth which were partly erupted. Many orthodontists use them as a routine second molar attachment for all cases, because of their greater comfort and unexpected effectiveness. They are bonded to the mesial cusps of second molars, in a different position from the full size tubes (Fig. 4.29A).

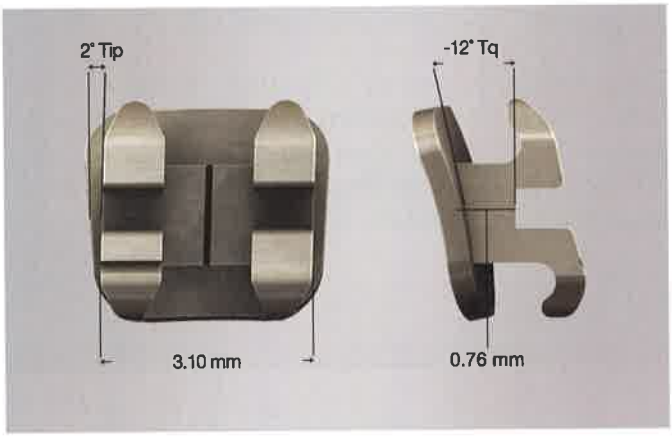


Fig. 4.26 The lower first premolar bracket maintains the original Andrews 2° of mesial tip. The -12° of torque gives an extra 5° of control compared with the research figure. The in-out is 0.76 mm and the width is 3.10 mm.

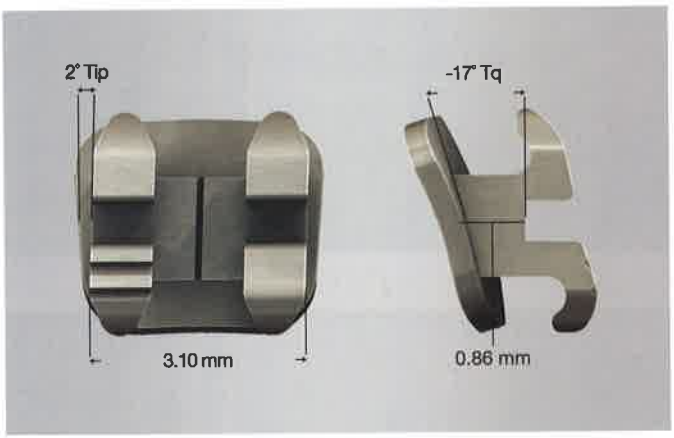


Fig. 4.27 The lower second premolar bracket maintains the original Andrews 2° of mesial tip. The -17° of torque gives an extra 5° of control compared with the research figure. The in-out is 0.86 mm and the width is 3.10 mm.

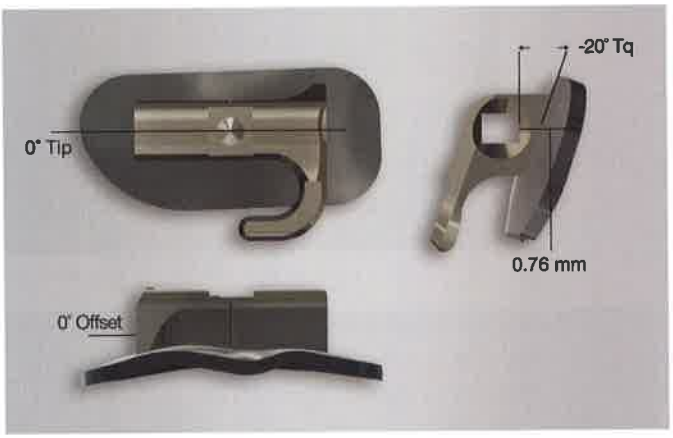


Fig. 4.28 The lower first molar tube has 0° of tip, –20° of torque, 0° of offset and is 4.40 mm wide. A tube is preferable to a convertible bracket, because this allows for correct occlusal positioning while avoiding occlusal interferences.

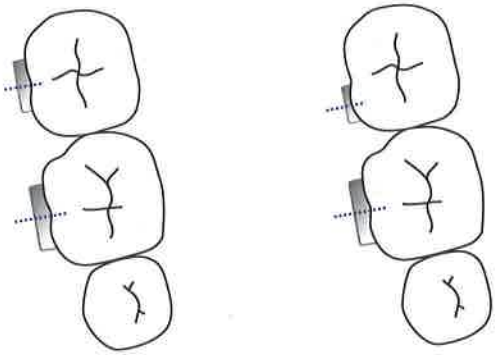


Fig. 4.29A The lower second molar mini-tube (right) is bonded on to the mesio-buccal cusp, which helps in cases where tissue covers the distal of the second molar and a tube is needed for bite opening.

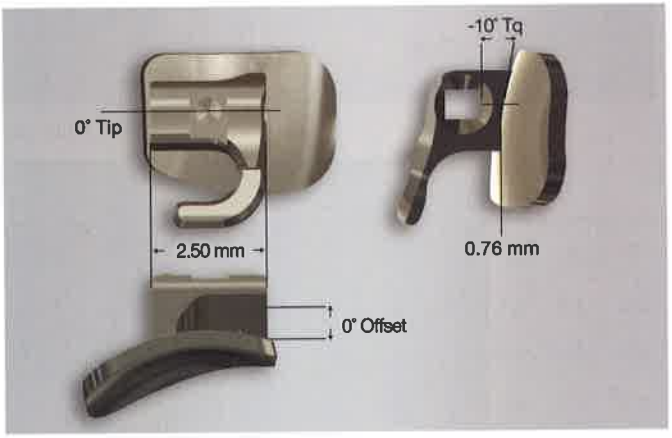


Fig. 4.29 The lower second molar mini-tube has 0° of tip, -10° of torque, 0° of offset and is 2.50 mm in the mesio-distal dimension. Despite its small size, it provides good tooth control and is more comfortable than a full-size tube.

Treatment sequence of case GS

This case shows the accuracy of the Avex™ appliance from Opal Orthodontics. The brackets featured accurate tip, torque, in-out and width values. When placed correctly, the appliance delivers a high percentage of cases treated to American Board and Angle Society standards.

Fig. 4.30

Fig. 4.35

The case was set up using indirect bonding, and brackets were placed correctly in the center of the clinical crowns (Chapter 6). They straddled the long axis of the clinical crowns, and care was taken to ensure accurate vertical positioning (Figs 4.39A & 4.39B).

Fig. 4.36

7	6	5	4	3	2	1	Upper
2.0	3.5	4.5	5.0	5.5	5.0	5.5	*Large teeth*
2.0	3.0	4.0	4.5	5.0	4.5	5.0	*Average for adult*
2.0	2.5	3.5	4.0	4.5	4.0	4.5	*Average for child*
2.0	2.0	3.0	3.5	4.0	3.5	4.0	*Small teeth*

Fig. 4.39A

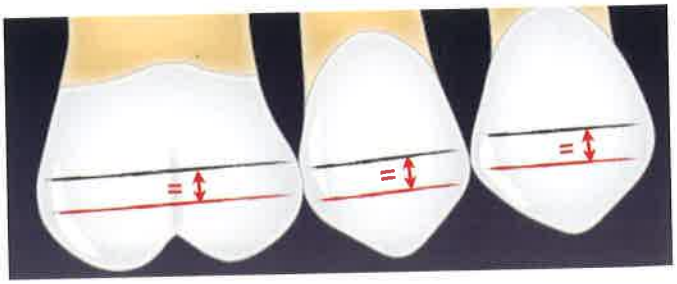


Fig. 4.39B

Fig. 4.31

Fig. 4.32

Fig. 4.33

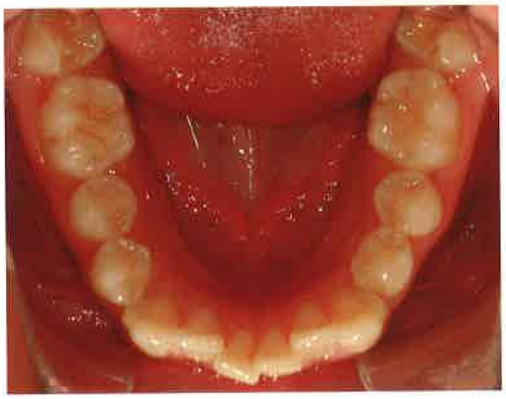


Fig. 4.34

Fig. 4.37

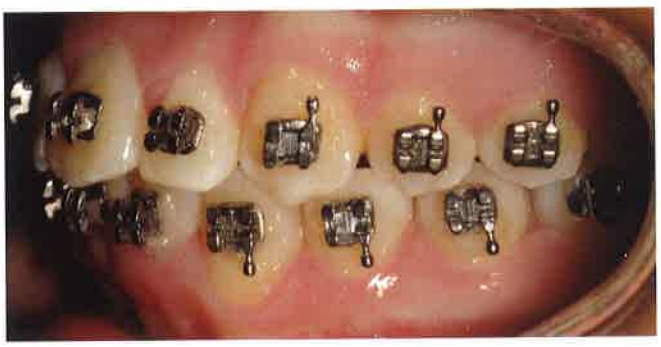


Fig. 4.38

Fig. 4.39C

Fig. 4.40

Case GS at the end of treatment (Figs. 4.41 – 4.45).

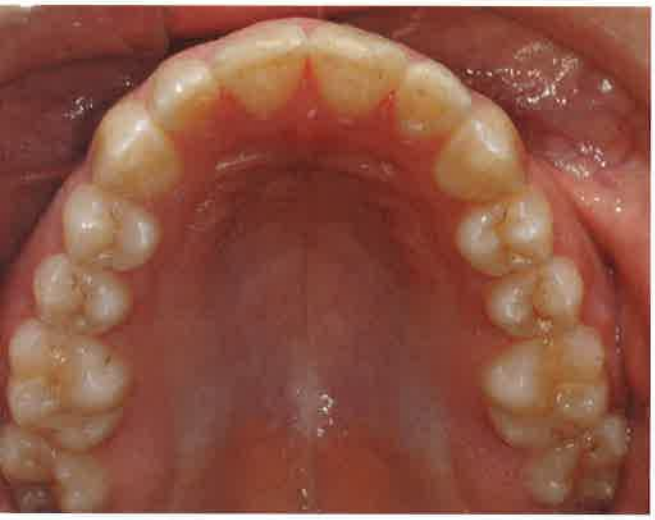
Progress was uneventful, and no arch wire bends were needed at the completion of treatment.

Fig. 4.41

Fig. 4.46

ig. 4.42

Fig. 4.43



g. 4.44

Fig. 4.45

REVIOUS BOOKS

2 Bennett J, McLaughlin R P. 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford ISBN 1 899066 91 8. Republished in 2002 by Mosby, Edinburgh ISBN 07234 32651

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CHAPTER 5

The different uses of brackets and tubes

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- For anchorage loss
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The different uses of brackets and tubes

If brackets and tubes can be used in different ways, less wire bending will be required from the orthodontist, and inventory needs will be reduced. This aspect of versatility was not a feature of the first two generations of the appliance, but was introduced with the third generation (B2 p. 99) and (B3 p.39). This chapter reviews the versatility and makes additional recommendations for the fourth generation.

Lower incisor brackets are interchangeable

The lower incisor brackets have zero tip and are interchangeable, which helps inventory control (Fig. 5.01).

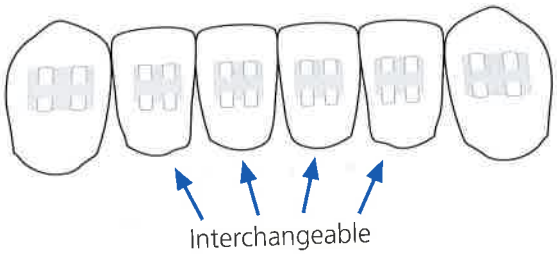

Fig. 5.01 The lower incisor brackets are interchangeable, left and right. This versatility helps inventory control.

Effective lower incisor root alignment

Going up from the normal .019 / .025 to a full thickness .021 / .025 wire applies extra lower incisor torque control without the need for wire bending. This is convenient for cases needing ideal alignment of lower incisor roots (Fig. 5.02). The use of full-thickness wires in this way is not effective if the slot is oversize [1,2] and is not possible with some self ligating brackets (Chapter 3).

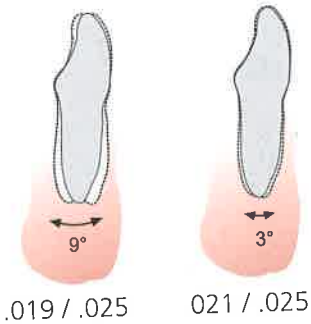

Fig. 5.02 A full thickness .021 / .025 wire applies extra torque control without wire bending. Ideal alignment of lower incisor roots can be easily achieved.

The .021 / .025 wire normally produces root alignment in three months or less. It can be of HANT (page 91) if the case is being treated to a standard ovoid, tapered, or square arch form. However, if an individualized arch form is being used, a non-bendable HANT type of wire is not appropriate, and a .021 / .025 steel wire needs to be made to the exact arch form.

Inverted lower incisor brackets (+6° torque)

There are three situations where it can be helpful to invert lower incisor brackets:

1. *In Class III cases.* Prolonged Class III elastics are needed in some Class III treatments, which can cause unwanted retroclination of lower incisors if using –6° torque brackets. In a few cases, lower incisor brackets can be inverted, to give +6° torque (i.e. lingual root torque) to help prevent this (Fig. 5.03). This is particularly beneficial in Class III cases (Case AY p. 132) where lower incisors are already upright or retroclined, and Class III elastics are needed.

2. *In cases where anchorage loss is needed.* These include many lower second premolar extraction cases, and some non-extraction cases with lower arch spacing. The +6° torque creates the needed lingual root torque to aid in effective anchorage loss.

3. *For individual incisor root correction.* Cases where a single lower incisor is proclined, it can be helpful to invert the bracket on that tooth. Care is needed, but this can be a convenient way to bring the root into bone (Case TB page 76).

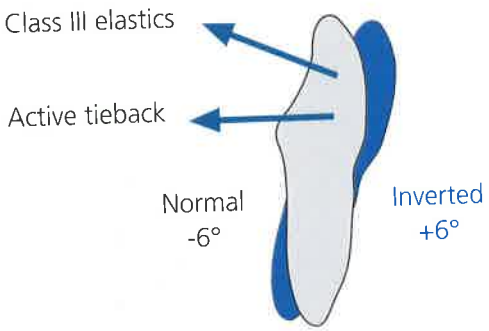

Fig. 5.03 Lower incisor brackets can be inverted in cases needing anchorage loss, and in a few Class III cases. This helps to prevent unwanted retroclination of lower incisors.

nverted upper lateral incisor brackets

In cases with palatally displaced upper lateral incisors it helps to invert the lateral incisor bracket, changing the torque from +10° to –10° (Fig 5.04). The authors described this in 1997, and have shown a published case (B2 p. 98 – 104) and treatment sequence (B3 p.43). The alternative is wire bending, but it is difficult and time consuming to introduce the exact amount of torque needed. Inverting the bracket is more precise and easier (B1 p.51).

Space needs to be made using coil springs (Fig 5.05). Attempts to move the crown labially before making space can worsen the root position, extending the treatment time. During space opening, adjacent brackets have wire ligatures, to prevent rotations (B2 p. 42).

The normal bracket is used for the displaced lateral incisor, but it is rotated through 180° (Fig 5.04). The tip stays the same at 8°. It is not correct to switch sides. The left bracket goes on the left incisor and the right bracket on the right incisor. Inverting the bracket applies labial root torque at the rectangular wire stage (Figs. 5.06 - 5.09).

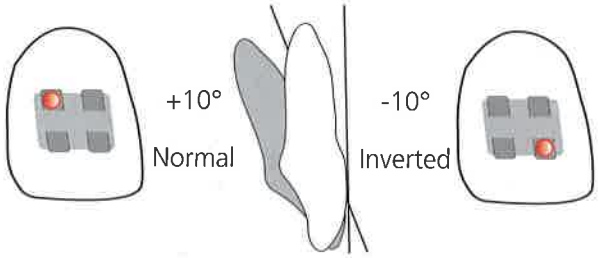

Fig. 5.04 For palatally displaced upper lateral incisors, inverting the bracket changes the torque from +10° to –10°. This is more precise than wire bending.

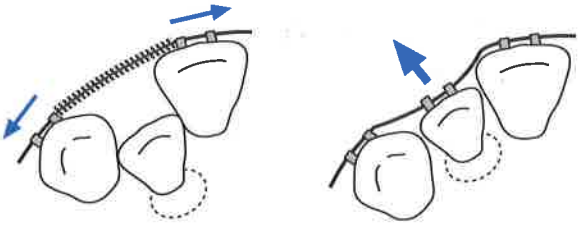

Fig. 5.05 A coil spring is used to create space, before moving the crown labially. Brackets on the adjacent teeth are tied with wire ligatures to prevent rotations.

Fig. 5.06 Crowding was relieved by extraction of first premolars. The upper lateral incisor was in crossbite, and the root was palatal.

Fig. 5.07 Space was made, and the case went into .019 / .025 HANT wire. The lateral incisor bracket was inverted, but the root is still palatally placed.

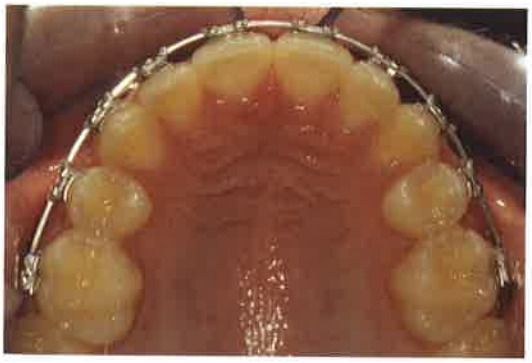

Fig. 5.08 .021 / .025 HANT wire was used for two months to correct the lateral incisor root. No wire bending was needed. Care is needed to avoid overcorrection.

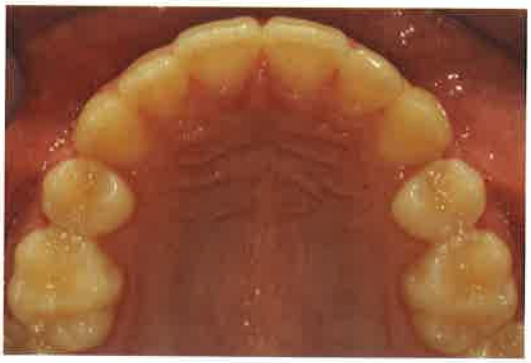

Fig. 5.09 The case two years after treatment. The lateral incisor root position remains good, and only a small amount of post-treatment change occurred.

Arch form and canine bracket selection

Arch form is an important factor when selecting canine brackets, and the authors have previously discussed this in detail (B2 p.45).

The research values of –7° for upper and –11° for lower canine brackets were obtained from non-extraction patients, with good dental arches [3]. Previously the authors used –7° upper canine and –6° lower canine brackets. Accordingly, when treating patients with well-developed arches, and provided substantial tooth movements are not required, the –7° for upper and –6° for lower are normally chosen. For patients with an ovoid or more tapered arch form the 0° torque canine brackets are often most appropriate, and for those with a narrow, tapered arch form (B2 p. 86) the +7° upper and +6° lower bracket option will be beneficial in many cases.

Fig. 5.10 This patient has well developed arches, and only routine tooth movements will be needed. The –7° torque option for upper canines and –6° for lowers are suitable.

Ectopic upper canines (palatal)

In a Caucasian population between 40 per cent and 85 per cent of ectopic canines are reported to be palatally displaced [4,5]. Early intervention by extraction of primary canines can be effective in up to 80 per cent of these cases (B2), but despite this, some require orthodontic correction, and it is normally a two stage process.

The first stage is to uncover the canine crown and move it into the line of the arch by a tipping movement, and there are many techniques for this (Fig. 5.12). The second stage involves correction of the canine crown and root positions, and the -7° torque bracket is ideal for this (Fig. 5.13). The canine root may be very poorly positioned, and the orthodontist often needs to work patiently through HANT wires for several appointments before placing the .019 / .025 steel wire. Excess force can cause crown discolouration or even loss of vitality.

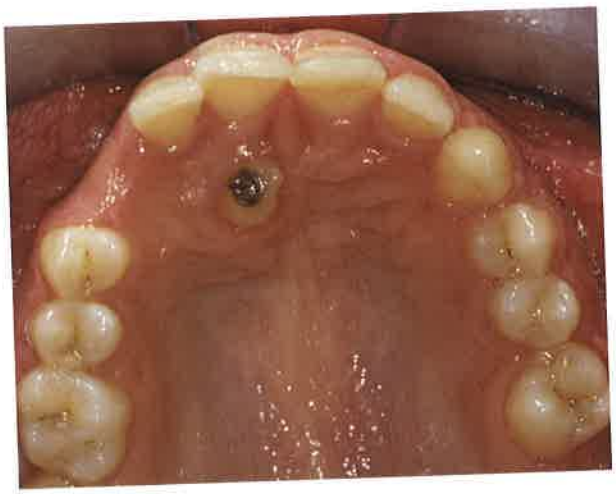

Fig. 5.11 The orthodontist often has to treat ectopic canines. The second stage involves correction of the canine crown and root positions, and the -7° torque bracket is ideal for this.

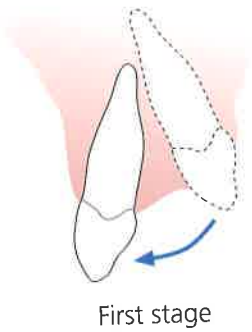

Fig. 5.12 After uncovering the canine crown, the tooth is moved towards the line of the arch by a tipping movement, during the first stage of correction. There are many techniques available for this.

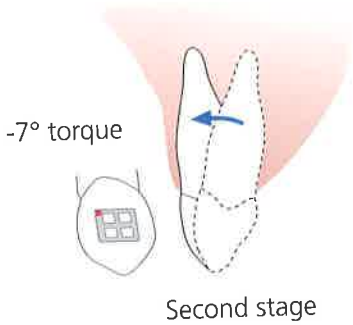

Fig. 5.13 The second stage includes correction of canine torque. Often the root is poorly positioned, and the orthodontist needs to work patiently through HANT wires for several appointments before placing the .019 / .025 steel wire.

Ectopic upper canines (buccal)

Upper canines can be palatally or buccally ectopic, and studies have shown geographical differences. Asian populations see relatively few palatally impacted canines, and a higher incidence of buccal displacement. For example a Korean study of 148 children found three times more buccally displaced than palatally displaced canines [6].

In these cases the canine may have partly erupted, or may need to be surgically uncovered. The crown is then moved into the line of the arch, and as with palatal canines, there are many techniques for this. For good root control the -7° torque bracket is not suitable, and should be inverted to give the +7° option, and guide the root into cancellous bone (Fig. 5.14).

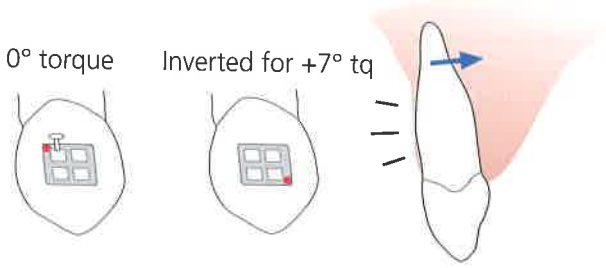

Fig. 5.14 In cases with buccally ectopic canines the -7° torque bracket should be inverted to give the +7° option, and guide the root into cancellous bone. This helps the mechanics and reduces the need for wire bending. In premolar extraction cases 0° or +7° is recommended.

Canine brackets after premolar extractions

After extraction of first premolars the treatment often involves correction of canine root tip, or bodily retraction of canines. The zero torque bracket, or the +7° option, are normally recommended for this (Fig. 5.14). The necessary tooth movements are difficult to achieve if the canine roots are against the cortical plate. They need to be in cancellous bone for effective movement.

Lower canine tip in Class III cases

There is incisor torque compensation after most non-surgical Class III treatments (Fig. 5.15). The lower incisors tend to be retroclined and the upper incisors proclined (page 275).

There is also tip compensation of lower canines in many of these cases (Fig. 5.15). In some treatments it is helpful to anticipate this, and to switch left and right lower canine brackets (Fig. 5.16). This changes the tip from +3° to -3° and can make the mechanics easier.

Canine control after RME

After rapid maxillary expansion (RME) it is helpful to use -7° torque brackets for good root control. There is a tendency for the crowns to tip towards the buccal during expansion (whether by RME or quadhelix) and use of -7° torque brackets encourages correction without the need for wire bending.

Fig. 5.15 Clinical photo of a Class III result, right side, with canines a fraction tipped distally.

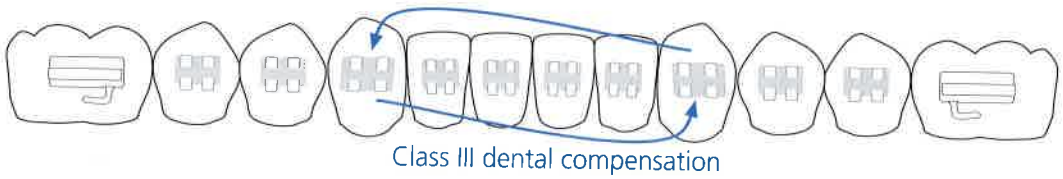

Fig. 5.16 In some Class III treatments it is helpful to anticipate tip compensation, and to switch left and right lower canine brackets. This changes the tip from +3° to -3° and can make the mechanics easier.

Agenesis of upper lateral incisors

When treating cases with agenesis of an upper lateral incisor, a decision is sometimes made to close the space and to move an upper canine into the position of the missing upper incisor (Figs. 5.17 - 5.19).

For good root control, it is an advantage to invert the -7° torque bracket on the canine to be moved mesially. The torque value of +7° guides the canine root towards cancellous bone, for ease of movement, and reduces the root prominence (the canine eminence) for better aesthetics (B1 p.51) (B2 p.47). It is not correct to switch sides, and the right side bracket is not placed on the left canine. The left side bracket is placed on the left canine. As with any orthodontic case, some wire bending is normally needed in these cases for ideal finishing, including applying buccal root torque to the first premolar after moving it mesially, for better aesthetics and function.

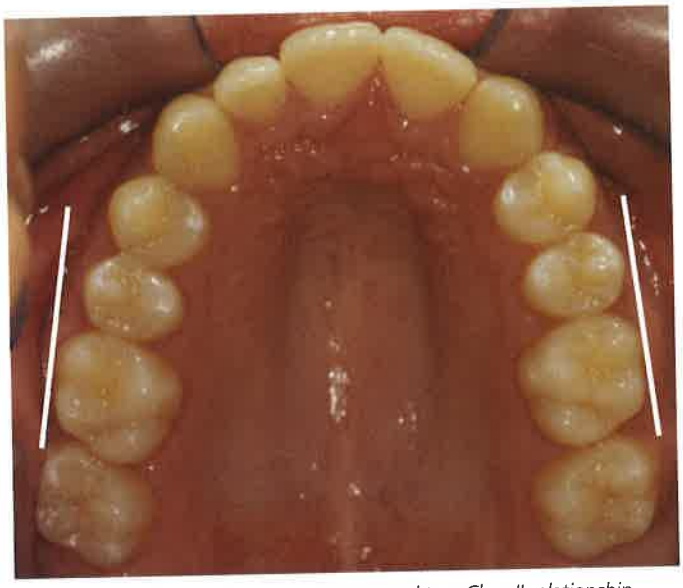

Fig. 5.17 The left side of the case was treated to a Class II relationship. The upper left first molar carried a lower right first molar tube, helping it to rotate mesially.

Fig. 5.18 The right side of the case was treated to a Class I relationship, with the first molar carrying an upper first molar tube, bonded in the normal bonded position. The -7° torque option was used for the canine.

Fig. 5.19 The left side of the case was treated to a Class II relationship, with the upper left first molar carrying a lower right first molar tube, bonded in a changed tip position. The +7° torque option was selected for the canine, which moved the root into cancellous bone and helped to reduce the length of the clinical crown.

Interchangeable upper premolar brackets

The bracket specification was developed to reduce the demands on anchorage. To make it easier to reach a Class I relationship in Class II treatments, the 2° research figure [3] was changed to 0°. This allows upper brackets to be fully interchangeable between left and right and first and second premolars (Fig. 5.20).

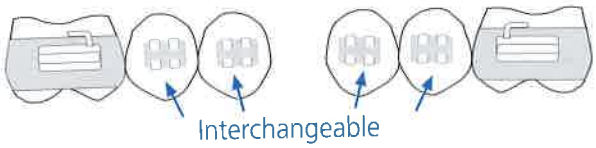

Fig. 5.20 The upper premolar brackets are fully interchangeable between left and right, and between first and second premolars.

Treating to a Class II molar relationship

Some cases need to be treated to a Class II molar relationship, and the number is tending to increase due to the reluctance of patients to wear headgear.

It is difficult to achieve good finishing and detailing in these cases, and some wire bending is normally needed. In a Class II molar relationship, the upper first molar needs to contact the lower second premolar (Fig. 5.21). This is accomplished by having the upper first and second molar brackets with 0° of tip and 0° of rotation. Two techniques have proved helpful.

- Lower first or second molar tubes can be used for the upper molars on the opposite side. For example, the lower right first molar attachment is used for the upper left molars (Fig. 5.22). These lower tubes will deliver zero rotation (compared with the normal 10° rotation), which helps occlusion and allows the molar to occupy more space in the line of the arch (B2 p. 51).
- The tube is placed at a different tip position, with more enamel from the mesial cusp visible than from the distal cusp (Fig. 5.21).

Some orthodontists use normal upper molar tubes to achieve most of the tooth movements, and then to switch to lower first molar tubes for finishing. Others use lower first or second molar tubes in the upper from the outset, when treating to a Class II relationship.

Another option for Class II molar cases is to use a specially designed tube with 0° rotation and -14° torque. The tube is welded asymmetrically on the base (Fig. 5.23) and this is being evaluated at the time of going to press.

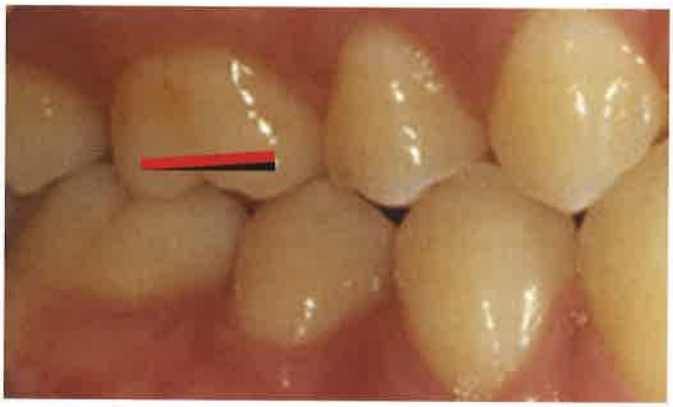

Fig. 5.21 When treating to a Class II relationship, the tube is bonded at a slightly different tip position (red) compared with the normal position (black). More enamel from the mesial cusp is visible than from the distal cusp.

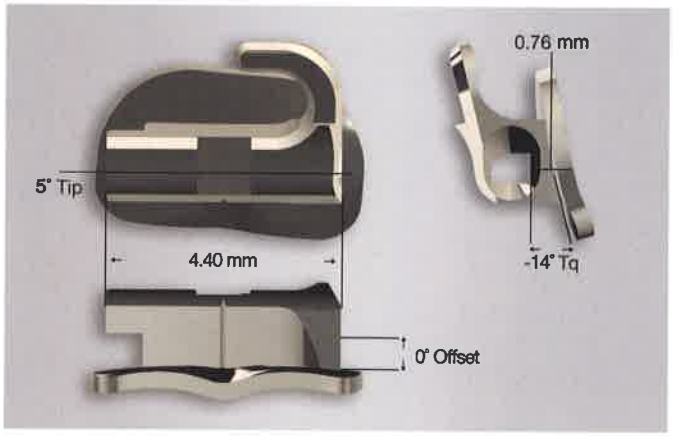

Fig. 5.23 A specially designed tube for Class II molars, with 0° rotation and -14°. torque, welded asymmetrically on the base.

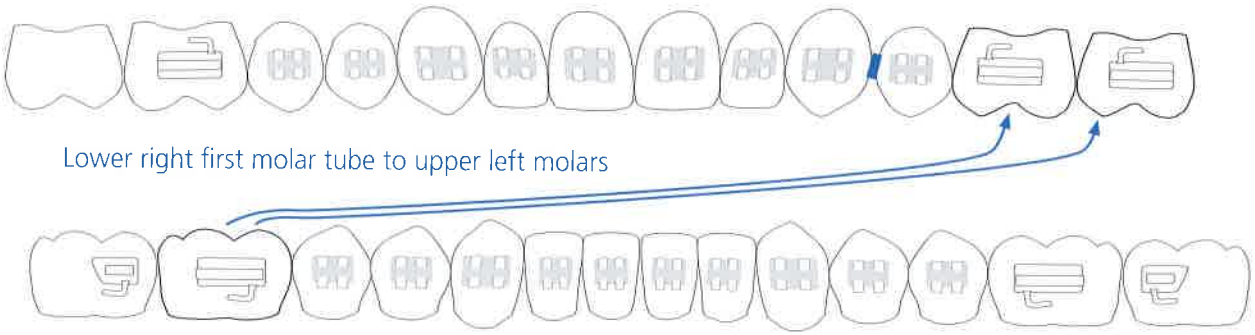

Fig. 5.22 When treating to a Class II molar relationship, lower first or second molar tubes can be used for the upper molars on the opposite side. Here the lower right first molar attachment is used for the upper left molars. The lower first molar tubes give zero rotation (compared with the normal 10° rotation) which improves the occlusion, and allows the molar to occupy more space in the line of the arch. The -20° torque gives a little more control as the molar moves mesially, compared with -14° of the normal tube.

PREVIOUS BOOKS

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B2 Bennett J, McLaughlin RP. 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford ISBN 1 899066 91 8. Republished in 2002 by Mosby, Edinburgh ISBN 07234 32651

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CHAPTER 6

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Setting up the case

With standard edgewise, the orthodontist needed wire bending skills to achieve good results, but with the preadjusted appliance, bracket positioning assumed new importance. Accurate appliance placement is needed for the built-in features to be properly expressed, and the orthodontist should be responsible for this, whether using direct or indirect methods. The authors advise against delegating bracket positioning to assistants.

During treatment, certain brackets or tubes which are not correctly bonded will require repositioning. There is no shame in changing a bracket or tube position. This is known as 'repo' and it is part of good technique. It is a mistake to continue treatment when there are obvious bonding errors, and these should be corrected without delay, or at an appropriate stage in the treatment.

Bracket and tube positioning

The principles of bracket and tube positioning are well established [1]. The reader is referred to previous texts (B2 p. 27 – 40) and (B3 p. 57 – 69).

Andrews used the long axis of the clinical crown (LACC) as a reference for bracket and tube positioning. From central incisor to second premolars this was a line drawn down the center of the middle developmental lobe of the crowns [1]. For molars it was a line drawn down the groove that lies between the two large buccal cusps.

For mesio-distal and axial positioning, the long axis of the clinical crown is the key reference line (Figs. 6.01 & 6.02). Vertically, Andrews recommended the midpoint of the long axis, but the authors found difficulties with this (B2 p. 29) and in 1995 they published a four-part study [2,3]. Subsequently, they used gauges, and this reduced the need for vertical repositioning (B2 p. 32–40). After 1999 they further improved vertical accuracy in the premolar regions by using Kalange's method [4].

With direct bonding it is helpful to avoid viewing the teeth from above or below, or from the side (B2 p. 59). The patient will need to turn the head from time to time, as the orthodontist changes seating position. Lip retractors can be used for direct bonding, but in the molar areas, access and accuracy are often better without them.

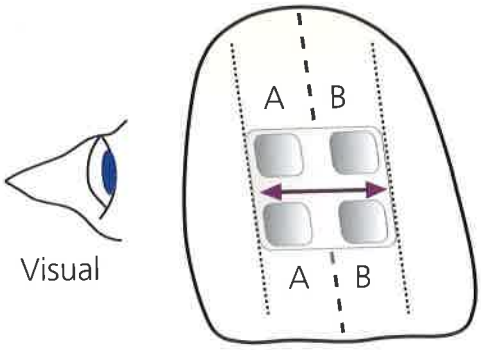

Fig. 6.01 The long axis of the clinical crown (LACC) is used as a reference for bracket and tube positioning. The bracket wings should straddle it.

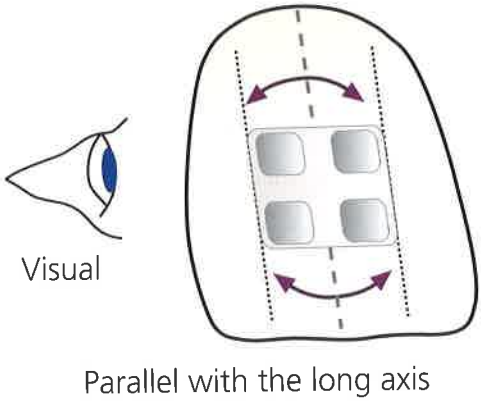

Fig. 6.02 For correct axial positioning, the bracket wings should be parallel to the long axis of the clinical crown (LACC).

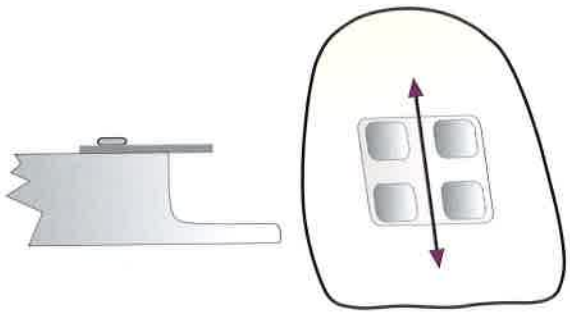

Fig. 6.03 The use of gauges and charts is recommended for accurate vertical bracket positioning.

Mesio-distal bracket and tube positioning

The bracket wings should straddle the long axis of the clinical crown, and be parallel to it (Figs. 6.01 & 6.02). During direct bonding, a mouth mirror should be used to check from the occlusal. Incisors and molars have relatively flat facial and buccal surfaces, and minor errors do not greatly affect the position of these teeth. Canines and premolars are more rounded buccally, and mesio-distal bracket positioning errors will cause rotations. Indirect bonding is more accurate, because lines can be drawn on the plaster teeth.

Rotated incisors. Bracket positions are not normally adjusted to overcorrect rotations. However, with rotated incisors, it is helpful to make a hint of overcorrection (B3 p. 61) to avoid an error in the other direction (Figs. 6.04 & 6.05).

Narrow incisors. The crown form of narrow upper incisors needs to be assessed before placing brackets, particularly with the upper laterals, because mesio-distal adjustment of bracket positioning is sometimes needed in these cases. If there is general spacing, and a plan to build up several anterior teeth, it is often helpful to complete the build ups as temporary or semi-permanent restorations before appliances are placed (Fig. 6.08). For adult cases, where build ups may be needed, a Chu® gauge [5] can be used to evaluate harmony of tooth width and length among upper incisors, which is important for ideal aesthetics (Figs. 6.06 and 6.07).The color coded measurements have a ratio of about 78%, for quick diagnosis of tooth size and proportion discrepancies [6]. Length and width are measured at the same time and the color coding reveals abnormal tooth proportions.

Lower canines. When direct bonding, lower canine brackets may drift distally before light curing, while the patient's head is on the headrest. To ensure good contact with the lateral incisors, the lower canine brackets should be placed on the vertical midline, or slightly mesial to it.

Upper premolars. With a Class II case, the upper premolar brackets can be placed slightly mesially of the long axis, to improve the occlusion. With a Class III case, they can be placed a little distally. The authors have tried this, but have reverted to normal positioning.

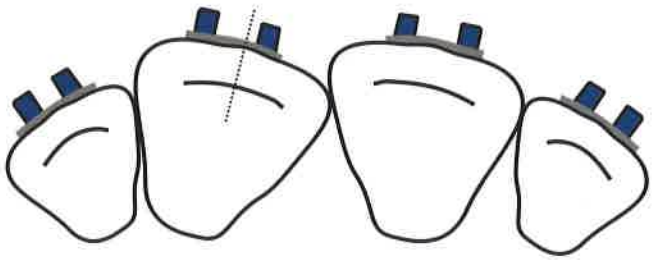

Fig. 6.04 With rotated incisors it is a common error to bond brackets in a position which does not straddle the long axis of the crown.

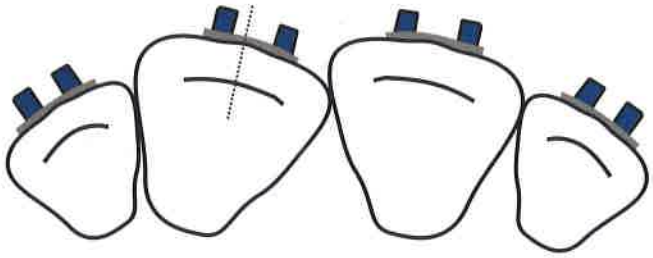

Fig. 6.05 When setting up cases with rotated incisors, it is helpful to make a hint of overcorrection to avoid a mesio-distal positioning error in the other direction.

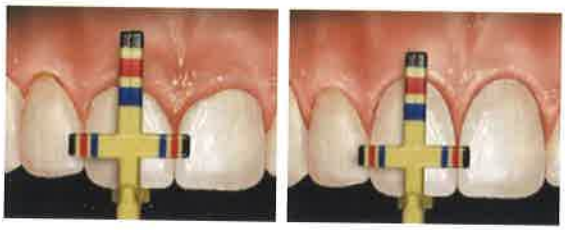

Fig. 6.06 (left) The Chu gauge reveals an incisor which is too wide for optimal aesthetics. Fig. 6.07 (right) The Chu gauge shows an incisor which is too narrow, compared with its length, for optimal aesthetics.

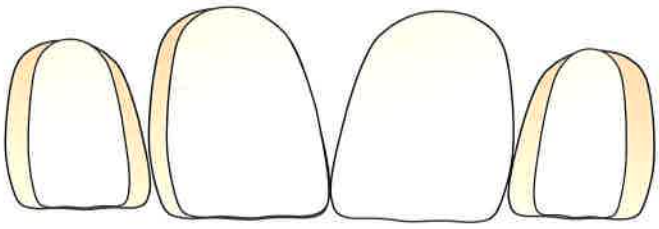

Fig. 6.08 In cases with general spacing and narrow incisors, it is often helpful to provide temporary build ups before setting up the case.

Lower first molars. Accurate tube placement is normally easier on small lower first molars if they have two buccal cusps, like lower second molars. The tube straddles the long axis, based on a line down the groove between the two buccal cusps. Large lower first molars need more care, as they often have three buccal cusps. It may be necessary to bond the tube a little distal to the buccal groove, or horizontal positioning may need to be coordinated with the lingual aspect of the tooth (Fig. 6.09).

Fig. 6.09 Larger lower first molars often have three buccal cusps. It may be necessary to bond the tube a little distal to the buccal groove, or to key off the lingual aspect of the tooth.

Axial bracket and tube positioning

The bracket wings should be parallel to the long axis of the clinical crown and evenly straddle it (Fig. 6.02). It is important to view the tooth surface directly from the buccal, and not from the side.

Incisors. It is normally not helpful to use the incisal edges of incisors, particularly upper laterals. There may be attritional wear or abnormal anatomy, which can cause errors.

Upper canines. Axial accuracy can be a challenge with upper canines, particularly if a tooth is partly erupted or has atypical crown anatomy, and there is no special remedy for this. Extra care is required, accepting the need for occasional repositioning. Canines have the longest roots in the dentition, and they should be bonded accurately.

Molars. Molar tubes are bonded parallel with the buccal cusps. When using molar bands, it is correct technique to cement them so that equal amounts of the mesial and distal cusps are visible (B3 p. 66 & 67).

Class II molars. For a Class II molar result, lower molar tubes from the opposite side can be used for the upper molars, with an axial adjustment (page 61).

Vertical bracket and tube positioning

The authors use gauges and charts for vertical accuracy (B2 p.38) (B3 p.62). This follows the principle of the middle of the clinical crown, but there are fewer vertical errors.

Bracket placement charts for non-extraction cases, and for first or second premolar extraction cases are shown opposite (Figs. 6.13, 6.14 & 6.15). It has been found that four rows are sufficient for most cases, especially in the lower arch. For very large or small teeth, the earlier five-row charts can be used (B2 p. 38).

Several fully erupted teeth in each arch are measured, either in the mouth or on the models (B2 p. 38). The chart is then used to decide an upper and lower row, based on the size of the patient's teeth. There may be a size difference between upper and lower arches. With experience, tooth size can be estimated visually, or using gauges.

After selecting a row of values, gauges are used for accurate vertical positioning (B2 p. 39) (B3 p. 60). Gauges are used differently in various areas of the mouth. For incisors the gauge is placed at 90° to the tooth surface (Fig. 6.11). For the canines and premolars it is parallel with the occlusal plane, and in the molar regions the gauge is parallel with the occlusal surface of each tooth (B3 p.62). When direct bonding, gauges can be pressed on to the bracket to remove excess bonding material from beneath the bracket base (Fig. 6.12).

For indirect bonding, Zand™ or MJ Measurement Marker gauges [7,8,15] are used to make pencil marks on the models. The MJ Measurement Marker gauge is preferred by the authors (Fig. 6.10). It allows easy measuring of tooth height and width (using the calliper ends) and very accurate bracket placement pencil marks.

Fig. 6.10 Here a MJ Measurement Marker is being used to mark the vertical position on upper incisors. Photograph courtesy of Dr. M. Koga.

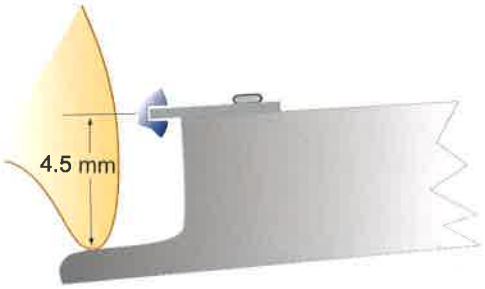

Fig. 6.11 For the incisors, the gauge is placed at 90° to the tooth surface.

Fig. 6.12 The gauge can be pressed against the bracket during placement, to remove excess bonding material.

7	6	5	3	2	1	Upper
2.0	4.0	5.0	5.5	5.0	5.5	*Large teeth*
2.0	3.5	4.5	5.0	4.5	5.0	*Average for adult*
2.0	3.0	4.0	4.5	4.0	4.5	*Average for child*
2.0	2.5	3.5	4.0	3.5	4.0	*Small teeth*

7	6	5	3	2	1	Lower
3.0	3.5	4.5	5.0	4.5	4.5	*Large teeth*
2.5	3.0	4.0	4.5	4.0	4.0	*Average for adult*
2.0	2.5	3.5	4.0	3.5	3.5	*Average for child*
2.0	2.5	3.0	3.5	3.0	3.0	*Small teeth*

Fig. 6.14 Upper and lower bracket placement charts, with recommended values for first premolar extraction cases.

7	6	5	4	3	2	1	Upper
2.0	3.5	4.5	5.0	5.5	5.0	5.5	*Large teeth*
2.0	3.0	4.0	4.5	5.0	4.5	5.0	*Average for adult*
2.0	2.5	3.5	4.0	4.5	4.0	4.5	*Average for child*
2.0	2.0	3.0	3.5	4.0	3.5	4.0	*Small teeth*

7	6	5	4	3	2	1	Lower
3.0	3.0	4.0	4.5	5.0	4.5	4.5	*Large teeth*
2.5	2.5	3.5	4.0	4.5	4.0	4.0	*Average for adult*
2.0	2.0	3.0	3.5	4.0	3.5	3.5	*Average for child*
2.0	2.0	2.5	3.0	3.5	3.0	3.0	*Small teeth*

Fig. 6.13 Upper and lower bracket placement charts, with recommended values for non-extraction cases. The Kalange method (page 71) is used for upper premolars.

7	6	4	3	2	1	Upper
2.0	4.0	5.0	5.5	5.0	5.5	*Large teeth*
2.0	3.5	4.5	5.0	4.5	5.0	*Average for adult*
2.0	3.0	4.0	4.5	4.0	4.5	*Average for child*
2.0	2.5	3.5	4.0	3.5	4.0	*Small teeth*

7	6	4	3	2	1	Lower
3.0	3.5	4.5	5.0	4.5	4.5	*Large teeth*
2.5	3.0	4.0	4.5	4.0	4.0	*Average for adult*
2.0	2.5	3.5	4.0	3.5	3.5	*Average for child*
2.0	2.5	3.0	3.5	3.0	3.0	*Small teeth*

Fig. 6.15 Bracket placement charts with values for second premolar extraction cases.

Clinical guidelines for vertical placement of anterior brackets

Bracket placement charts and gauges are used for vertical accuracy because they deal with difficulties such as partly erupted teeth, tooth length discrepancies, labially and lingually displaced roots, and gingival hyperplasia [2,3].

Incisors may have irregular incisal edges, due to enamel fractures, attritional wear, pronounced mamelons, or other reasons. These should be discussed at the consultation appointment, so that the patient can agree the planned management.

If there is major enamel damage (Fig. 6.16) good orthodontics will normally be easier if a temporary or 'semi permanent' restoration is placed before treatment. Later, care will be needed to avoid damage at appliance removal. The patient should be aware of this small risk, and that such restorations often need replacing after orthodontics for ideal aesthetics. No adjustment to vertical bracket positioning is required for a correctly restored tooth.

In many cases anterior teeth have minor enamel damage or unaesthetic mamelons (Figs. 6.17 & 6.18). These will require enamel reshaping, which will slightly reduce the length of the clinical crown (B3 p. 64). It would seem logical to do this before bracket placement (B2 p. 37) but not all patients like the idea of taking away enamel before appliances are placed. Also, in some cases it can be easier to judge the amount of enamel adjustment after tooth alignment. Accordingly, it is often better to place the bracket a little more gingivally at the setup, and reshape enamel during treatment.

When setting up a case with a deep bite, some orthodontists find it helpful to bond the incisor brackets 0.5 mm more incisally, and for a case with an open bite, to bond the brackets 0.5 mm more gingivally.

If the case has pointed canines it is helpful to reshape them before bracket placement, if the patient is agreeable (B2 p. 37). Otherwise, the canine bracket should be bonded a little more gingivally, in anticipation of later reshaping after levelling and aligning.

Fig. 6.16 It is normally easier to provide good orthodontic treatment if teeth with major enamel damage can be restored before bracket placement. No adjustment is made to vertical bracket positioning in this situation, but extra care will be needed during appliance removal.

Fig. 6.17 Incisors may have unaesthetic mamelons which will require minor enamel adjustment during treatment. The brackets should be bonded a little more gingivally at the setup.

Fig. 6.18 If incisors have minor enamel damage, the necessary enamel reshaping will slightly reduce the length of the clinical crown. If enamel adjustment is planned during treatment, the brackets should be bonded a little more gingivally at the setup.

Marginal ridge accuracy with upper premolars

Marginal ridges can be defined as 'elevated convex crests that form the mesial and distal occlusal margins of posterior teeth'[9].

At the end of treatment the marginal ridges in the molar and premolar regions should be at the same level. This in turn will ensure proper occlusal contacts and flat bone levels in a healthy individual. The ABO uses marginal ridges to grade the proper vertical positioning of molars and premolars, and requires the marginal ridge of adjacent posterior teeth to be 'at the same level or within 0.5 mm of the same level' in an ideal result [10].

The authors use and recommend the Kalange method [4] along with bracket placement charts and gauges. The three-step Kalange process is quick and easy when indirect bonding, but it can also be used with direct bonding, by making measurements on a study model and applying them in the mouth (Figs. 6.19, 6.20, 6.21 & 6.22A & B). It is mainly applicable in the upper arch, but can be used for lower premolars when appropriate.

Fig. 6.22A In this case the Kalange method was used when setting the brackets for indirect bonding, and the marginal ridges became well aligned early in treatment.

Fig. 6.19 Step one. A line in red is drawn joining the marginal ridges of the first molar and first and second premolars.

Fig. 6.20 Step two. The bracket and tube height values from the bracket positioning chart are marked in black for all teeth except the premolars.

Fig. 6.21 Step three. Finally, black lines are drawn to mark the position for the premolar brackets.

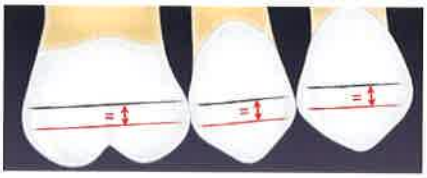

Fig. 6.22B The distance red to black lines for the premolars should be the same as the distance red to black lines for the first molar tube. This ensures alignment of marginal ridges.

Molar tubes

Low profile non-convertible molar tubes are preferred. They are stronger, more comfortable, and cause fewer interferences than convertible tubes. They are normally bonded, but for cases with deep molar overbites or where lingual or palatal arches are needed, molar bands are used.

If using bands, good separation is needed (B3 p. 66 & 67) and it is helpful if the molar tubes are welded more to the occlusal on the bands, rather than to the gingival. The lower first molar tube should be welded at 2.0 mm or 2.5 mm. If bonding, the second molar tubes are bonded well to the occlusal in both arches, and the first molar tubes, particularly in the lower arch, should not be too gingival (Fig. 6.23)

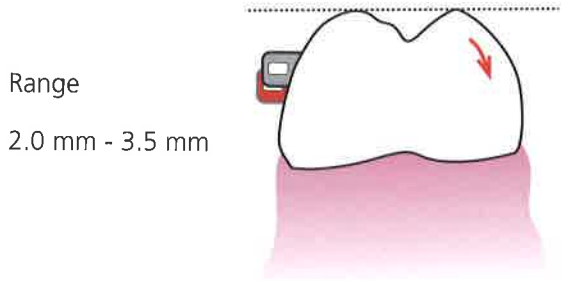

Fig. 6.23 It is an error to position lower first molars tubes too far to the gingival, either to avoid occlusal interference or due to the welding height on the band. Correct vertical positioning is needed to avoid unwanted torque changes and poor alignment of marginal ridges.

White spot lesions (WSLs)

Orthodontic treatment brings an increased risk of enamel white spot lesions, due to the presence of fixed appliances [11]. The decalcification is attributed to prolonged plaque accumulation around the brackets. It is beyond the scope of this book to give an in-depth review of this unfortunate side effect, but there are steps which can be taken to reduce the risk, as discussed below.

Patient awareness and WSLs

Plaque control should be an area of focus from the patient's first visit to the practice. If there is a need for improvement, positive changes need to be seen before going into fixed appliances, otherwise in some cases the authors will decline to provide treatment.

Good brushing and dietary control are helpful in avoiding WSLs, but other factors play a part, including the individual's bacterial flora (Fig. 6.25). Some patients show poor cooperation with brushing, and do not have decalcification. Conversely, others appear to have good oral care, but experience WSLs.

It is helpful to build early patient confidence and communication. This leads to improved levels of cooperation later in the treatment, when good tooth brushing and plaque control will be needed to reduce the risk of white spot lesions.

It is necessary to provide patients with written information and photos of decalcification before treatment. If WSLs are seen later due to poor brushing or dietary control, the handouts can be referred to during any discussion.

Fig. 6.25 It is necessary to provide patients with written information and photos of decalcification before treatment. They need to be aware that good oral care will be needed throughout. Marginal gingivitis and poor plaque control, as seen on this transfer case, are risk factors for WSLs and possible caries.

Fig. 6.24 There is an increased risk of enamel white spot lesions (WSLs) developing during orthodontic treatment with fixed appliances, due to prolonged plaque accumulation.

Orthodontist awareness and WSLs

The best strategy, along with the bonding method described below, is for the orthodontist to assess the risk factors before the case setup, and identify those who need special attention. The file can be marked, and fluoride rinses, reinforcement of oral hygiene, and dietary advice can be given. In some cases there is a sharp increase in the number of WSLs during the first 6 months of treatment [12]. Oral hygiene should be closely watched in the early months of treatment, so the patient can be informed and extra measures can be used to prevent demineralization.

Bonding technique and WSLs

Acid etching of enamel surfaces is essential for good bond quality, but unfortunately the enamel becomes more susceptible to decalcification [13].

Previously, only a small area was etched, sufficient for the bracket base (Fig. 6.26). A preferred method involves etching the whole labial surface and then covering it with a protective layer of sealant, 38% filled by weight [14]. The labial surface is etched and dried with a gentle hair dryer or tooth dryer (Fig. 6.27). Opal Seal™ is applied sparingly, to avoid excess sealant and potential yellowing, all the way to gingival margin (Fig. 6.28). A gentle stream of air, directed from the gingival, takes out the ethanol and avoids ledges. In this way the surface is sealed, with no risk of voids. LED light curing is used, and in vitro evidence shows less decalcification (5%) on teeth that are sealed in this manner [13]. At every second or third adjustment visit the sealant is checked using a black light (Fig. 6.29) and reapplied as needed during treatment.

It is helpful to write a letter to referring dentists, explaining the technique. A little more time is needed at the appliance removal and clean up stage.

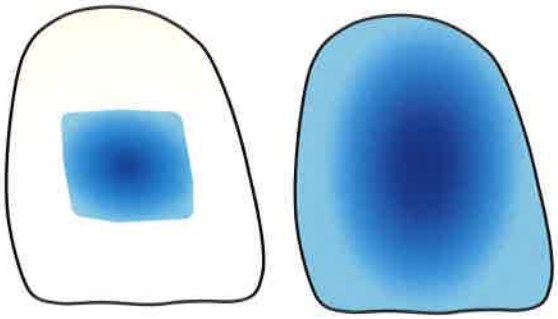

Fig. 6.26 On the left, only a small area is etched, sufficient for the bracket base. A preferred method involves etching the whole labial surface (right) and covering it with a protective layer of sealant.

Fig. 6.27 In this case lower brackets are being placed using indirect bonding. The whole labial surfaces of the upper teeth have been etched in preparation for application of the sealant.

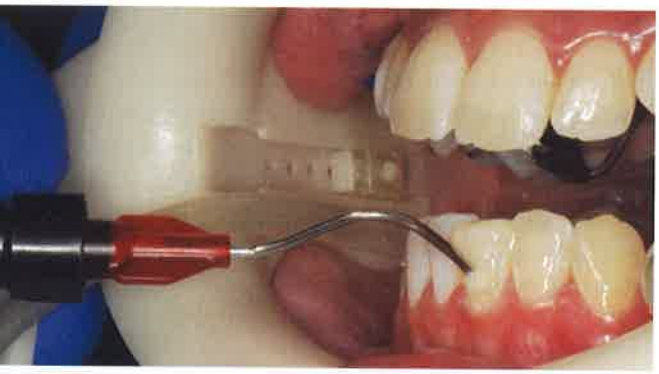

Fig. 6.28 After the labial surface has been etched and dried with air from a low volume cool hair dryer, Opal Seal™ is applied sparingly to the whole enamel surface, all the way to gingival margin. After this, a gentle stream of air, directed from the gingival, takes out the ethanol and avoids ledges as it sets hard.

Direct and indirect bonding of appliances

With the direct bonding method, brackets and tubes are placed one at a time by the orthodontist, after etching and drying the teeth. This is tiring work, and accuracy can be difficult to achieve, especially with younger patients. Accurate bracket positioning is essential in modern orthodontics, and indirect bonding is recommended. Careful technique is needed, but greater accuracy is possible, and there are other advantages, such as patient comfort and doctor time.

In their 2003 text (B3 p. 69) the authors noted 'There is currently renewed interest in indirect bonding, owing to the improved adhesives which have been developed, better tray materials, and upgraded designs of retractors'.

In the past decade there have been further improvements in both materials and procedures, so indirect bonding is now preferred by the authors and many practices, ahead of direct bonding.

Fig. 6.29 The sealant is checked using a black light, and reapplied as needed during treatment. With sealants, a little more time is needed at the appliance removal and clean up stage.

Fig. 6.30 Direct bonding of brackets and tubes is difficult and tiring work for the orthodontist. Accuracy is sometimes hard to achieve, especially with younger patients.

Fig. 6.31 Accurate bracket positioning is essential in modern orthodontics, and indirect bonding is recommended.

The advantages of indirect bonding

Setting brackets and tubes on to a model is more precise than doing so directly in the mouth, and improved accuracy is particularly evident in the molar regions when using indirect bonding. In the laboratory the soft tissue and saliva factors do not exist, and the teeth can be easily viewed from any direction. There can be a methodical and unhurried approach to the whole process.

When setting up cases with direct bonding, many patients dislike prolonged use of retractors and a long appointment. With indirect bonding the setup appointment is normally a shorter and more pleasant experience.

Less doctor time is needed with indirect bonding. A trained laboratory person sets the brackets on the models in approximately the correct positions. The orthodontist needs only a few minutes to check the setup and make corrections.

The orthodontist can manage several chairs simultaneously when using indirect bonding, while maintaining a calm and unhurried approach. When placing brackets and tubes using trays, much of the work can be delegated to well trained assistants, without compromising the quality of the setup (Fig. 6.31).

It is important to inform the patient that a technician was responsible for tray construction and other laboratory procedures, but the detail bracket positioning was by the orthodontist.

Most orthodontists will agree that setting up cases by direct bonding is hard work. It is physically demanding and tiring, if done well. The appointment is less of a strain if indirect bonding is used, leaving more time and energy for other activities.

Indirect bonding can be relied upon to position the appliance more accurately than direct bonding. Hence it can be assumed that less repositioning will be needed, which shortens treatment time in some cases.

Making the switch to indirect bonding

There is a 'learning curve' when switching to indirect bonding, because setting up a case requires several stages, and precise techniques are needed for each. Accordingly, among the early cases with indirect bonding there may be one or two failures, but an attitude of determination and persistence will be well rewarded.

For the reader who wishes to make a switch, a different text is in preparation, to provide a full understanding of the techniques involved [15]. In addition, various websites and YouTube have detail recommendations. It is beneficial to communicate with a practice where indirect bonding is already used.

Indirect bonding may not be suitable for a smaller, low volume practice. A laboratory, or at least a separate area, is needed for setting brackets on to models and for tray construction, and considerable lab time is required. Ideally there should be a technician with laboratory facilities in the practice, but if space is limited, a specific area can be set aside, and normally this will suffice.

Patients are scheduled about a week before appliance placement. This is for high quality impressions and for thorough cleaning of the teeth. At the following visit, when the appliance will be placed using trays, extensive cleaning procedures are avoided, because they may cause release of crevicular fluid and contaminate the bonding.

Normally a week of time is allowed for the laboratory work to be completed to a high standard.

There are some additional practice costs due to the extra appointment and the laboratory work for indirect bonding. However, the most valuable item in an orthodontic practice is always 'doctor time' and the saving in this, plus the reduced need for bracket repositioning, will normally outweigh any extra expenses incurred elsewhere.

Indirect bonding is an excellent method of setting up most routine cases. However, there are malocclusions where the teeth are very irregular, or where one or more teeth are ectopically erupted, which are better managed with direct bonding. It is therefore necessary to maintain the capability to use both methods in a practice.

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Case report TB

This 14.0 year old female was a transfer patient. She showed a Class I skeletal and dental pattern with previously placed orthodontic appliances. There was no crowding in her arches and she was being treated on a non-extraction basis. The lower left central incisor was labially displaced and showed some gingival recession. The lower second molars were not included in the set up, and the marginal ridges were not well levelled between lower first and second molars.

T.B.
BEGINNING
14.0 yrs

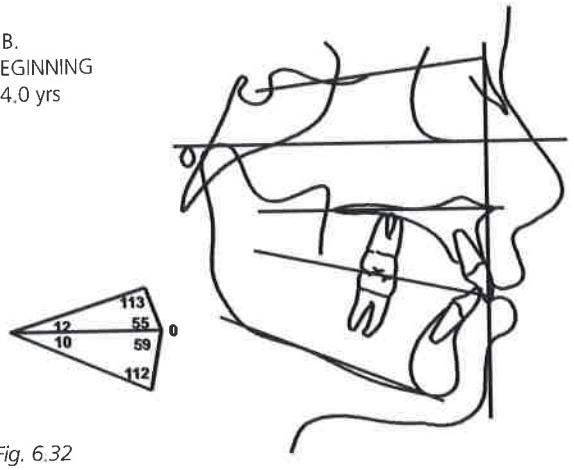

Fig. 6.32

SNA 79°
SNB 76°
ANB 3°
A-N ⊥ FH -3 mm
Po-N ⊥ FH -11 mm
WITS 0 mm
GoGn SN 25°
FM 21°
MM 21°
↑1 to APo 8 mm
↓1 to APo 4 mm
↑1 to Max Plane 113°
↓1 to Mand Plane 112°

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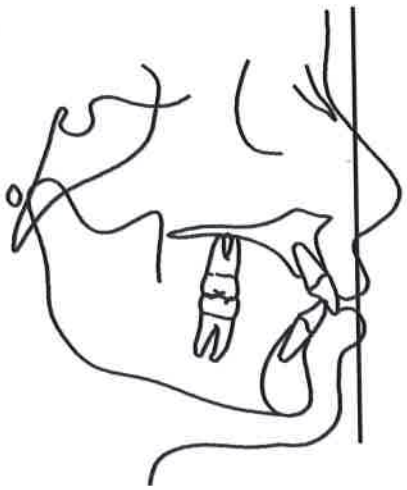

Fig. 6.33

↑ Incisor torque to occl. plane 53°
↑ Incisor tip to TVL -7
↑ Lip thickness 11 mm
↑ Lip to TVL 3 mm

Max. anterior height 24 mm
↑ Lip length 19 mm
↑ Incisor exposure 6 mm
Inter-labial gap 4 mm

Occlusal plane to TVL 99°
↓ Incisor torque to occl. plane 55°
↓ Lip thickness 12 mm
↓ Lip to TVL 2 mm
Soft tissue 'B' point -6 mm
Soft tissue pogonion -7 mm

Cephalometrically the patient showed Class I skeletal pattern with good soft tissue balance. Her upper incisor torque and A-P position, as well as her upper lip thickness, were ideal. There was a low angle pattern, with MM at 21°, and lower incisors were proclined at 112°.

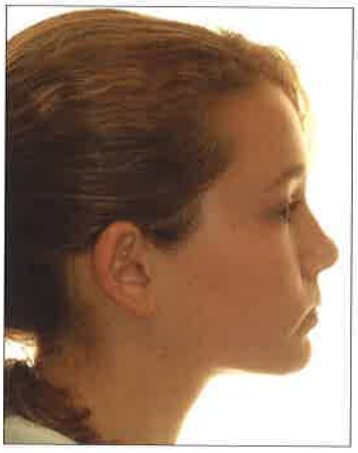

Fig. 6.34

Fig. 6.35

Fig. 6.36

Fig. 6.37

Fig. 6.38

Fig. 6.39

Fig. 6.40

Fig. 6.41

Fig. 6.42

Brackets and tubes were removed and replaced using indirect bonding procedures (Fig. 6.46). Lower second molars were included (Fig. 6.47) to begin correction of the marginal ridge relationship with the lower first molars and to assist in overbite control.

Light .016 HANT wires were placed after re-bracketing.

The lower incisors were proclined, and interproximal enamel reduction (IPR) was carried out from distal of the lower left lateral to the distal of the lower right lateral, using finishing strips. The lower occlusal view shows the need for torque correction of the lower left central incisor root (Fig. 6.47).

Fig. 6.43

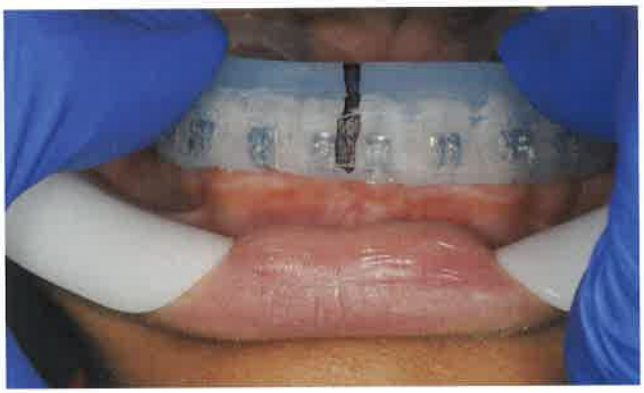

Fig. 6.46

The case progressed to .0195 / .025 HANT wires, (Figs. 6.49 – 6.51). These wires are most effective and can be used for two to three visits. They introduce the component of torque and are excellent at managing tip and in/out issues.

Fig. 6.49

At the following visit the lower left central incisor bracket was inverted (Figs. 6.52 – 6.54) creating +6° torque. Local lingual root torque was required to move the root back into the alveolar process, away from the cortical plate. Light elastic chains were used to close minor spaces.

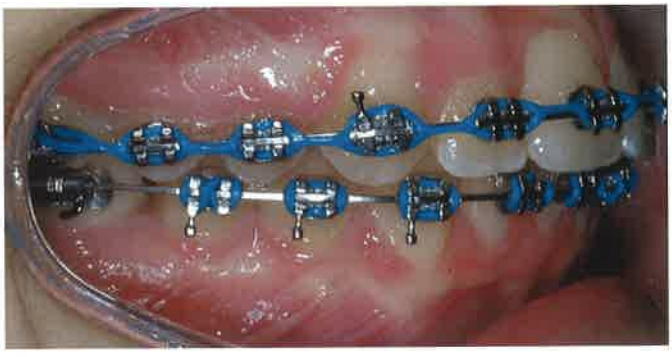

Fig. 6.52

Fig. 6.44

Fig. 6.45

Fig. 6.47

Fig. 6.48

Fig. 6.50

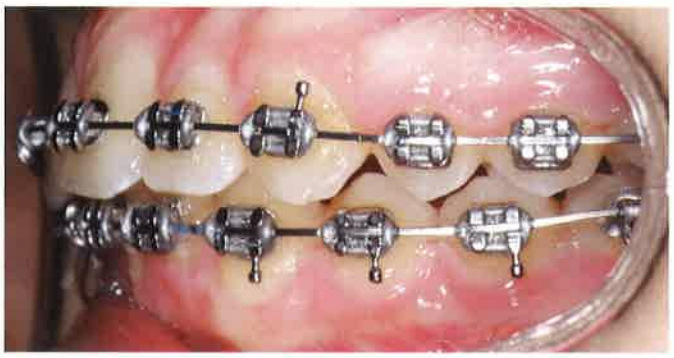

Fig. 6.51

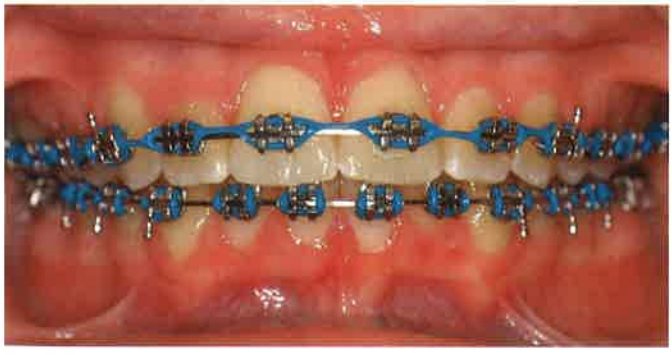

Fig. 6.53

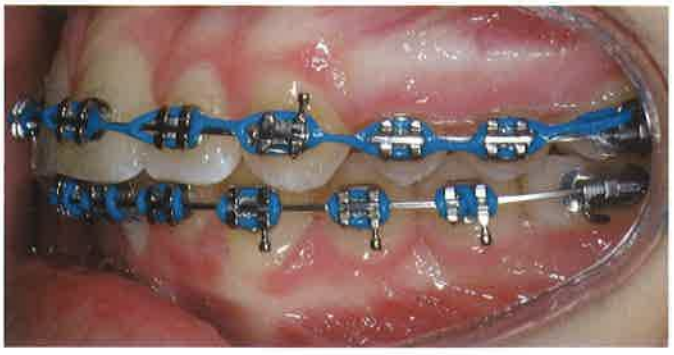

Fig. 6.54

The lower incisor brackets have -6° of lingual root torque. When inverted, the +6° of torque introduces 12° of lingual root torque to the tooth (Fig 6.55). The torque position of the lower left central incisor is showing favorable change. Good improvement is seen (Figs. 6.56 & 6.59) compared with the starting position (Figs. 6.38 & 6.41).

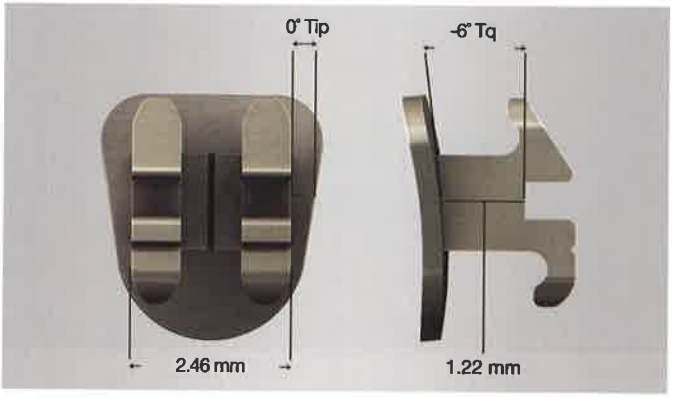

Fig. 6.55

Slight overjet remained at this stage of treatment. Therefore, IPR was completed in the upper arch using finishing strips. Elastic chains were used for final space closure. Class II elastics, from the posted .0195/.025 steel wires, were worn for a short time. The lower left central incisor continues to show good improvement.

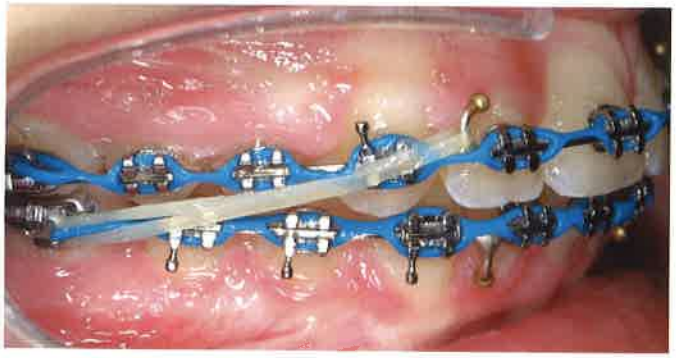

Fig. 6.58

There was no wire bending needed during treatment. The overbite and overjet have been corrected, and there is good occlusion after Class II elastic wear (Figs. 6.61 – 6.63). The patient is now ready for settling.

Fig. 6.61

In this case light elastic chains were used on a light wire during settling, for closure of small remaining spaces in the upper arch. In this situation molar offsets are required to prevent rotation of the molars (Fig. 6.64) as discussed in detail in chapter 12.

The occlusal photos show excellent in-out positioning of teeth.

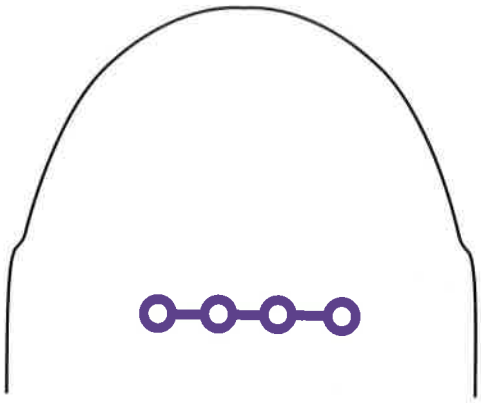

Fig. 6.64

Fig. 6.56

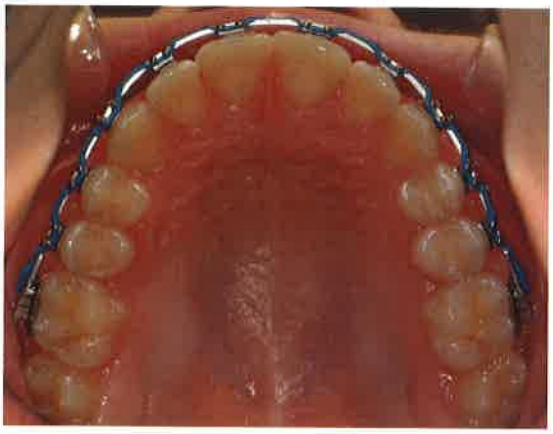

Fig. 6.57

Fig. 6.59

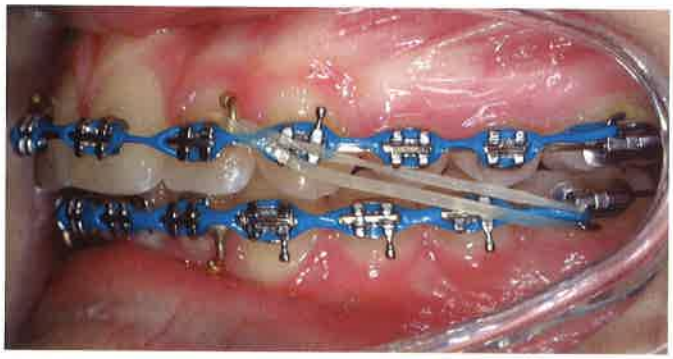

Fig. 6.60

Fig. 6.62

Fig. 6.63

Fig. 6.65

Fig. 6.66

The final intra-oral photos show good occlusion, alignment and in/out relationships. The inverted lower left central incisor bracket effectively moved the root back into the alveolar process, away from the cortical plate.

T.B.
FINAL
15.0 yrs

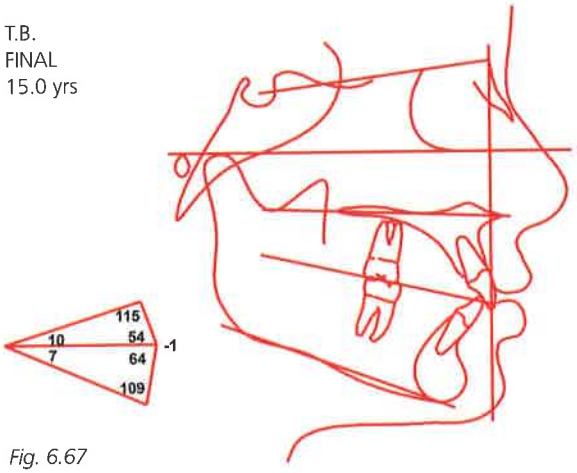

Fig. 6.67

SNA 78°
SNB 75°
ANB 3°
A-N ⊥ FH -4 mm
Po-N ⊥ FH -8 mm
WITS -1 mm
GoGn SN 24°
FM 20°
MM 18°
↑1 to APo 7 mm
↓1 to APo 3 mm
↑1 to Max Plane 115°
↓1 to Mand Plane 109°

T.B.
FINAL
15.0 yrs

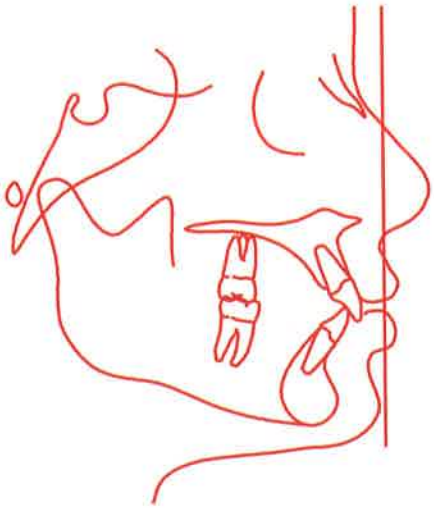

Fig. 6.68

↑ Incisor torque to occl. plane 52°
↑ Incisor tip to TVL -8mm
↑ Lip thickness 12 mm
↑ Lip to TVL 4 mm

Max. anterior height 26 mm
↑ Lip length 20 mm
↑ Incisor exposure 6 mm
Inter-labial gap 3 mm

Occlusal plane to TVL 100°
↓ Incisor torque to occl. plane 61°
↓ Lip thickness 13 mm
↓ Lip to TVL 3 mm
Soft tissue 'B' point -5 mm
Soft tissue pogonion -2 mm

The final facial photos and cephalometric tracings showed good facial balance and good cephalometric values. The MM angle reduced to 18° and the lower incisor torque was 109° compared with 112° at the time of transfer. The panoramic radiograph confirms that the roots were well aligned compared with the positions at transfer.

Summary

This case demonstrates that with correct bracket selection and ideal bracket positioning, orthodontic treatment proceeds smoothly, achieving predicable and accurate end results. This case confirms the statement 'bracket placement is the most important mechanical step in orthodontic treatment'.

Fig. 6.69

Fig. 6.70

Fig. 6.71

Fig. 6.72

Fig. 6.73

Fig. 6.74

Fig. 6.75

Fig. 6.76

Fig. 6.77

CHAPTER 7

Archwires and arch form

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- Lower canine buccal uprighting

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Archwires and arch form

The arch form research has been previously discussed by the authors (B3 p.71). There are two important principles:

- The mandibular bone is the main factor determining the form of the human dental arch, and there is variation in the shape of this.
- In many cases, if arch form is changed, it tends to return to its original shape. Therefore, the pre-treatment arch shape is normally the best guide for arch form.

It is difficult to respect arch form, in the same way as it is not always easy to stay within the speed limit when driving. However, respect for arch form is needed, beyond mere 'lip service', which means 'pretending that you believe a certain thing, but not practicing that belief'.

It is a mistake to ignore speed limits, because there will be accidents. In the same way, if we disregard arch form and recklessly expand cases, time after time, there will be relapse and periodontal problems. It is not good orthodontics.

Variation in the shape of the mandible

Arch form has been discussed for over a century, and ideal geometric forms were sought [1,2,3]. However, the search was not logical, because of the great variability in the size and shape of human arch form and mandible [4,14]. In the lower arch the teeth erupt from the underlying bone, the shape of which is to some extent genetically determined [16]. As the teeth erupt into the oral cavity they are influenced by the musculature and other environmental factors. There is great variability.

The pre-treatment shape of the arch

If arch form is changed, it tends to return to its original shape, and the pre-treatment shape of the arch is the best guide to use for arch form. This view is widely supported by the literature [5,6,7] and the authors have previously reviewed this (B3 p.71)

The authors believe that archwires need to be customized to reduce the risk of relapse and to achieve good aesthetics. For example, if a wide arch form is used for an individual with a narrow facial pattern, there will be a risk of relapse or periodontal breakdown, and an unnatural look to the smile.

When can arch form be changed?

The arch form can be changed, within the limitations of the alveolar process, in the following situations:

- In patients with a relatively narrow maxilla, and a mandibular arch that is tending to collapse lingually, with an associated deep curve of Wilson (Case IC page 64).
- In deep bite cases where lower canines are inclined lingually, and influenced by the upper teeth.
- Digit sucking or lip sucking cases, where the arch form is affected by an influence such as the thumb and that influence will be removed during treatment (Fig.07.01).

Fig. 7.01 Digit sucking may affect the upper and lower arch forms. When it ceases, a stable change can be expected.

From the above comments, it can be concluded that three types of case may be suitable for buccal uprighting of lower canines or slight inter-canine expansion.

Deep bite cases, including Class II/2. Due to the influence of the upper canines, the lower canines are often inclined lingually in these cases. As the bite opens, the lower canines can be uprighted (Fig. 7.04). This change can be expected to remain stable, provided the deep overbite remains corrected [9].

RME cases. After rapid maxillary expansion, slight lower arch widening can be stable [8,10] and an average of 1.1 mm of stable canine change has been reported [11].

Cases with a lingually erupted lower canine. A lower canine may erupt lingually, into a position which is clearly out of the main arch form. This may be due to crowding or for other reasons. During treatment this tooth will be moved buccally to a corrected position in the line of the arch, in soft tissue balance between the tongue and the other oral musculature. This corrected position is likely to be stable.

Respecting inter-canine width

There is overwhelming evidence that lower arch expansion will be unstable (Fig. 7.02), and will result in lower anterior relapse in as much as 70% of cases [4]. Despite this, the most popular nickel-titanium archwires available from major orthodontic companies were found to produce average canine expansion of 5.9 mm in the lower, and 8.2 mm in the upper arch [12,13]. Two terms are used in this discussion, and their meaning is as follows:

- Lower inter-canine expansion (Fig. 7.03) describes movement of one or both lower canines in a labial direction. There may be a lack of bone or periodontal tissue in the expanded position.
- Lower buccal uprighting (Fig. 7.04) describes a torque change, often seen during bite opening. Only the incisal edge of the lower canine (or the occlusal edge of a premolar or molar) crown tends to move labially. The root apex moves lingually, with most of the tooth remaining in an unchanged position.

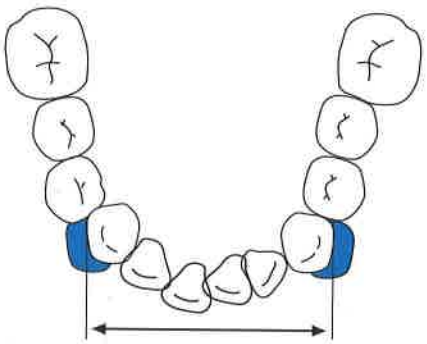


Fig. 7.02 Lower inter-canine expansion is normally an error. It is likely to result in lower anterior relapse or periodontal problems in as much as 70% of cases.

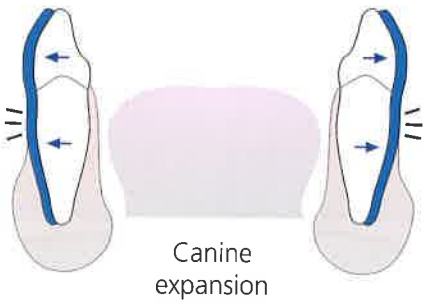


Fig. 7.03 After lower inter-canine expansion there may be a lack of bone or periodontal support for the canine roots in the expanded position. It is a mistake to disregard arch form.

Examination of the lower arch

Careful examination of the lower arch provides information which is helpful in achieving good results.

Basic shape. In 1932, Chuck described three main shapes for the human arch form as square, tapered and ovoid [17]. Other authors discussed this classification, and orthodontic companies (in response to published literature) provided these three main arch forms. The authors have chosen to use templates in these three shapes in the early stages of treatment to select the appropriate shape as described in the next section, 'Managing arch form – part one'.

Influences. The shape of the dental arch form may be affected by environmental factors, and these may be reversible or permanent. They include digit sucking, an over active mentalis muscle, the size and behaviour of the tongue and the effect of the upper arch in deep bite cases. Some influence can be reversed by treatment, such as digit sucking or a deep bite, but abnormal size or activity of the tongue or mentalis muscles may be difficult to reverse.

The shape of the alveolus in the lower molar area. If there is adequate mandibular basal bone it may be possible to change lower molar crown position without the risk of relapse or periodontal consequences (Fig. 7.05). Alternatively, if the alveolar housing is narrow, the treatment options will be limited.

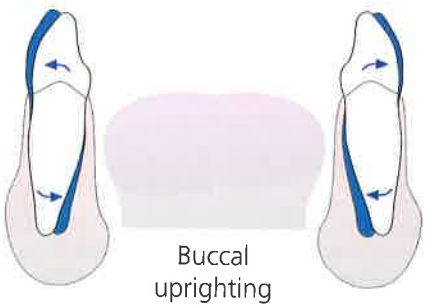


Fig. 7.04 The term 'lower canine buccal uprighting' describes a torque change. The crown tends to move labially and the root apex moves lingually. Bone and periodontal support is the same.

The curve of Wilson. If the case has a steep curve of Wilson there will be buccal uprighting and widening in the lower molar and premolar areas, in response to the torque effect of well fitting rectangular wires (Fig. 7.05). If the alveolar housing is wide, the arch form widens as buccal uprighting occurs and frequently causes a crossbite. Early widening of the maxilla with RME needs to be considered for cases with a steep curve of Wilson (Case IC page 64).

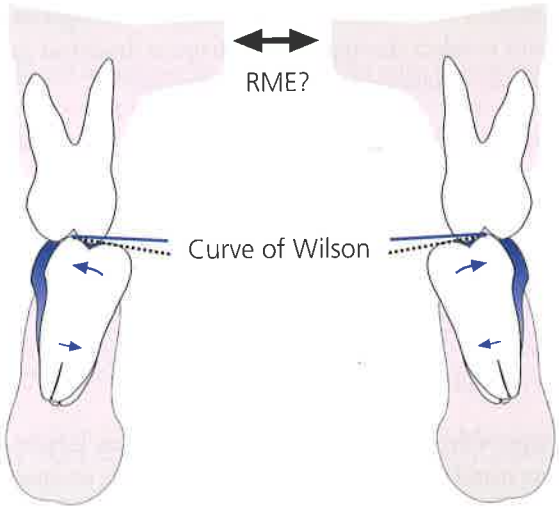


Fig. 7.05 In cases with a steep curve of Wilson, lower molar uprighting occurs during levelling, and brings a crossbite risk. RME is often needed at the start of treatment (Case IC page 94).

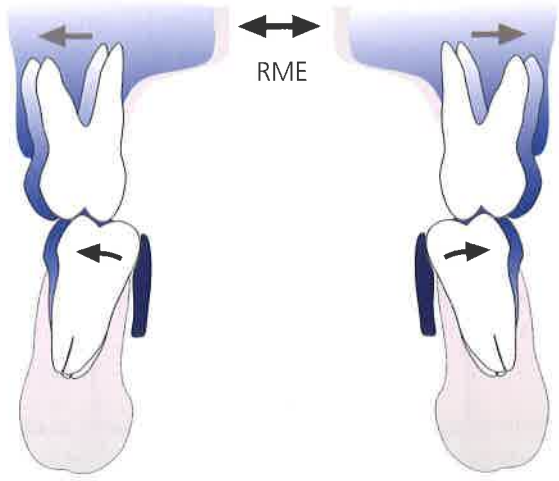


Fig. 7.06 Early widening of the maxilla with RME needs to be considered for cases with a steep curve of Wilson. The lower arch becomes wider during levelling and aligning, and there is a risk of a molar crossbite developing if the maxilla is not wide enough to allow buccal movement of upper molars.

Managing arch form – Part one

A two part system has been described previously, and continues to be recommended, with some small improvements. The reader is referred to the earlier text for detailed information and illustrations (B3 p. 72 – 84).

Before placing the first arch wires, the lower arch form is examined using three clear templates –square, tapered and ovoid (Fig. 7.07). The shapes are slightly different from previously described shapes, in that the posterior segments of the three arch wire shapes no longer merge together, but remain apart from first bicuspid to second molar (Fig. 7.08)

The patient's lower model is assessed, particularly in the canine and premolar areas, to decide the most appropriate template. The chosen arch form is noted, and white plastic templates are used for shaping the arch wires into tapered, ovoid or square shapes during levelling and aligning, up to and including the rectangular HANT stage (Fig. 7.07). All stainless steel wires are shaped. Rectangular HANT wires are stocked in the three arch forms, because these wires are difficult to shape. The exception is the opening .016 HANT wire, which has little effect on arch form, and is used in a tapered shape in all cases.

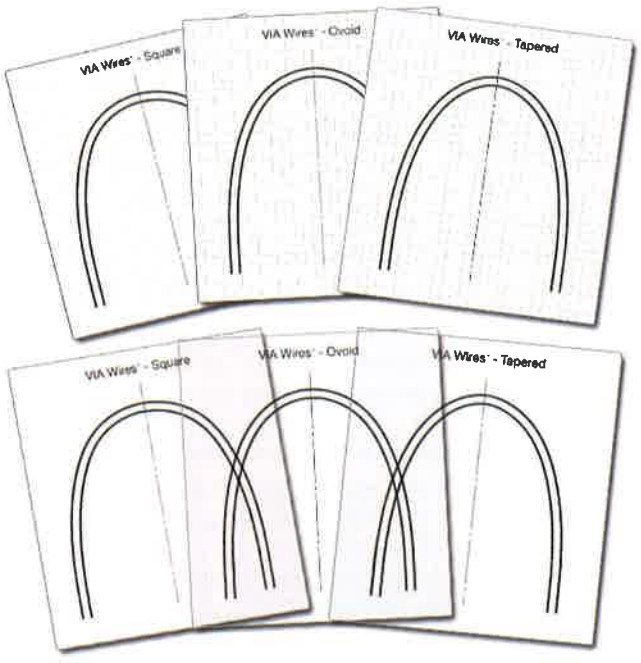
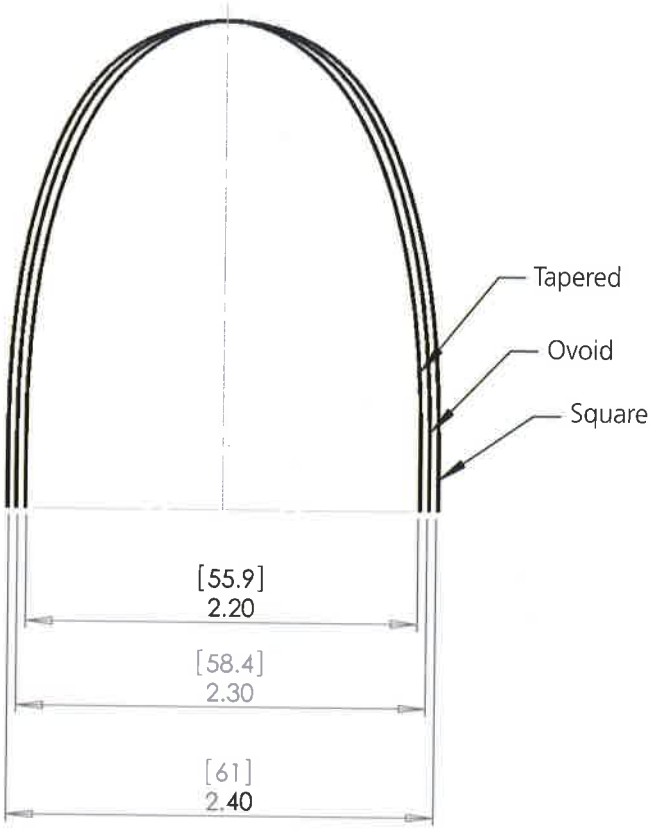


Fig. 7.07 Before placing the first arch wires, the lower arch form is examined using three clear templates (below) in square, tapered and ovoid shapes. White plastic templates (above) are used for shaping the arch wires into the chosen form during levelling and aligning, up to and including the rectangular HANT stage.



ig. 7.08 Superimposed (overlaid) images of the lower tapered, ovoid, nd square arch forms used by the authors. These are slightly modified rom previous archforms, in that the posterior parts from first premolar o molars maintain their width. Molar widths are shown in millimeters above) and inches (below).

Managing arch form – Part two

Before going to steel rectangular wires, an individual arch form (IAF) is made for each patient. It is based on the form of the lower dentition.

Towards the end of the rectangular HANT wire stage, softened base plate dental wax is pressed down on the lower arch, so that the brackets leave indentations (Fig. 7.09). The wax is removed from the mouth, taking care to avoid distortion. The bracket indentations are used to shape the .019/.025 rectangular steel wire, as a basis for an individual arch form (Fig. 7.10). This IAF is checked for symmetry, using the white plastic template, and compared with the starting lower arch form, to ensure that there are no significant inaccuracies.

The lower IAF wire shape is photocopied, and used for all lower rectangular steel wires, as well as any smaller wires needed in the progress of the case. In nearly all situations, the upper arch form is made in a shape coordinated to the lower, and 3 mm wider (Fig. 7.11A).

g. 7.09 To prepare an individual arch form (IAF) soft wax is pressed own on the lower arch, so that the brackets leave indentations. The IAF used for all rectangular steel wires, and any smaller wires that may be eeded later in the case.

Fig. 7.10 The bracket indentations are used to shape a .019/.025 rectangular steel wire, as a basis for an individual arch form.

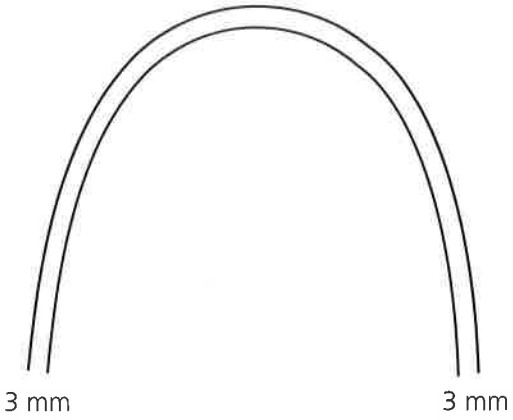


Fig. 7.11A The lower individual arch form wire shape is photocopied, and used for all lower rectangular steel wires. An upper arch form is made, coordinated to the lower, and is 3 mm wider all around.

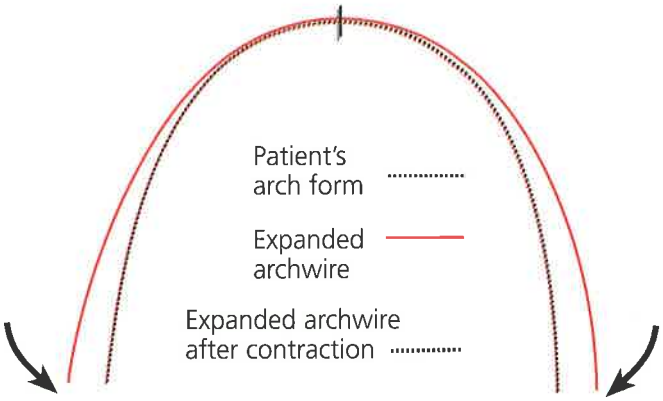


Fig. 7.11B The upper wire should be correctly expanded, to avoid narrowing or widening in the canine area. Buccal root torque is added, to reduce the risk of the palatal cusps hanging down as the molars move buccally.

Expanded upper archwires

Rectangular steel wires, made to the IAF, are used in many cases without modification (Fig. 7.11A). In some situations the upper shape needs to be varied, and the usual upper/lower arch wire coordination is not the same (B3 p. 77).

If the case requires upper arch dental widening, a rectangular steel wire should be used. It should be expanded in a way that fits the arch form when the ends of the expanded wire are pressed back towards it (Fig. 7.11B) and buccal root torque is added to encourage bodily movement.

If a wire is incorrectly expanded, there may be unwanted narrowing or widening in the canine area. If torque is not added, there will be a risk of the palatal cusps of upper molars hanging down, causing functional interferences. In some cases, if there has not been earlier RME, molar movement may be prevented due to a lack of maxillary bone.

After earlier RME or quadhelix treatment, it helps to widen the upper rectangular steel arch wire and add buccal root torque.

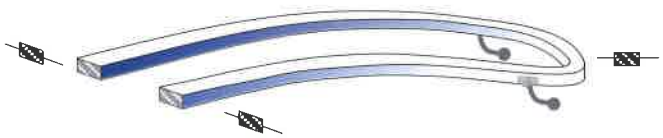


Fig. 7.11C It is seldom necessary to add 'reverse curve' or 'anti Spee' to the working wires, provided they are of good quality and the guidelines for overbite control are followed.

Overbite control

There are five requirements for overbite control. Deep bites can be routinely and easily corrected in most cases if these are followed.

Use of the .022 slot and steel wires. The bigger slot size allows a .019 / .025 steel working wire which is almost 50% more rigid than the .016 / .022 wire normally used with the smaller .018 slot [15].

Avoidance of premolar extractions in low angle cases. If premolars are extracted in a low angle case, overbite control is difficult to maintain while closing residual space. Non-extraction treatment favors bite opening (B3 p. 134) and extraction treatment favors bite closure.

Including lower second molars in the set up. The early banding or bonding of lower second molars is most beneficial in bite opening (B3 p. 136).

Selective use of Class II elastics. Using Class II elastics in average or low angle deep bite cases can help the bite opening effect (Book 3 p. 138).

Allow time for the mechanics to have effect. Time is needed. It can take two or three months for the lower canine roots to move distally as the curve of Spee levels (B3 p. 137).

Rectangular steel .019 / .025 wires are used flat for the first two or three months. It is seldom necessary to add 'reverse curve' or 'anti Spee' if the above guidelines are followed, using high quality heat treated wires (Fig. 7.11C).

Archwire types

Certain wires are required to practice the technique correctly (Table 1). Along with these, the authors sometimes use beta titanium wires or other similar wires that are bendable. Also, full thickness .021 / .025 wires in HANT or steel are used in a few cases, where fuller expression of the bracket specification is needed, and these are particularly helpful in aligning lower incisor roots.

Wire type	Specification	Uses and stock advice
HANT Heat Activated Nickel Titanium .016 .019/.025	Transition temperature is 27° C +/- 5° C. The HANT wire is heat treated by way of a proprietary process at very high temperatures. The process was developed to reduce a lot of inconsistencies and variation.	The .016 HANT wires are stocked only in tapered shape. The .019 / .025 HANT wires are stocked in all three shapes – ovoid, square, and tapered.
STEEL .014 .016 .018 .020	The stainless steel type 304 LV raw material is diamond drawn for the smoothest surface finish available. The exacting tensile specifications for round wire were developed specifically for the orthodontic industry. The spring temper provides a resilient characteristic within the material limitations.	Stocked only in tapered shape, and adjusted as needed before placement.
STEEL .019 / .025 With soldered ball end hooks.	The hooks are of solid brass with a swaged ball end. The brass material plays a vital role in the soldering of the hooks. The proprietary process used during the soldering process eliminates annealed transitions that in the past had a major impact on the mechanical properties of the archwire.	The average hook positions are 36 mm symmetrically apart in the upper arch and 26 mm apart in the lower arch. Also having wires that have hooks 38 and 34 mm apart in the upper arch, and 24 and 28 mm apart in the lower arch will fit approximately 90% of patients in the average practice. Those outside these values can be managed with crimpable hooks or elastic chains and Kobyashi hooks. Stocked only in tapered shape, and adjusted to the patient's IAF before placement.

Table 1. The above wires are recommended to practice the technique correctly.

Arch wire sequencing

Non-extraction cases. Arch wire sequencing is often easy with non-extraction cases, because of minimal crowding, with little need for space closure late in treatment (Chapter 9). The initial arch wire is normally a .016 round HANT wire, although sometimes a slightly smaller HANT wire is used. These excellent wires are normally in place for one or two periods of four to six weeks. The light forces are comfortable for the patient, who is new to orthodontic tooth movement.

The second wire is normally a .019 / .025 rectangular HANT wire, which is very effective for individual tooth alignment, although occasionally a .016 / .022 HANT wire can be used. The .019 / .025 rectangular HANT wires can be used for two or three periods of four to six weeks each, and can be retied for individual teeth as needed. At this point, if the curve of Spee needs correction, .020 round heat treated steel wires are used (Table 2) for their stiffness and levelling capability.

If Spee levelling is not required, heat treated .019 / .025 rectangular stainless steel 'working wires' are placed (Table 3). These wires are the workhorses for the major tooth movements, including overbite and overjet correction, and space closure. The wire options for finishing the case are discussed in chapter 12.

First premolar extraction cases often have anterior crowding. Bodily retraction of canines is preferred, using larger round stainless steel wires, to minimize tipping. Brackets are initially placed on only the well aligned incisors, so that the case can rapidly progress to heavier round stainless steel wires (Case RO page 200). The case starts with the .016 HANT wires for one visit, followed by movement through round heat treated steel wires to the .020 round wire. Canines retract in response to lacebacks. After elimination of anterior crowding, the remaining incisors can be bracketed and the case is managed as in the non-extraction discussion above.

Second premolar extraction cases are normally 'minimal anchorage cases' with a need to lose anchorage, move molars mesially, and minimize tipping into the extraction sites. Placing brackets on first molars and first premolars, and using a .019 / .025 sectional steel rectangular wire for local space closure is recommended (Case NH page 222). After closing or reducing the second premolar space, the other teeth are bracketed, and arch wire sequencing is similar to the non-extraction approach described above.

Non extraction	Purpose
.016 HANT .019/.025	Levelling and aligning
.014 STEEL .016 .018 .020	In cases with a deep bite or an open bite, a selection of steel wires is used, appropriate to the case. In this way, good overbite correction and control is achieved.
.019 / .025 (hooks) STEEL	Working wires, bent to the patient's IAF for the main stages of treatment. Overjet and overbite control, and space closure.
Finishing wires for settling the occlusion.	See chapter 12 for the range of options.

Table 2.

Non extraction – no overbite issues	Purpose
.016 HANT .019/.025	Levelling and aligning
.019 / .025 (hooks) STEEL	Working wires to the patient's IAF for the main stages of treatment – overjet and overbite control, and space closure.
Finishing wires for settling the occlusion.	See chapter 12 for the options and methods used.

Table 3.

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PREVIOUS BOOKS

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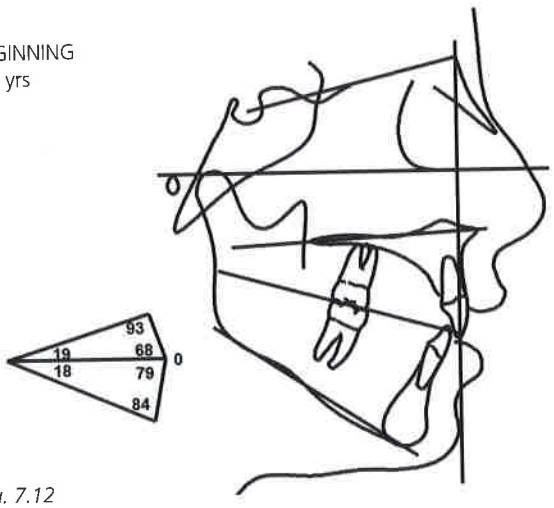
Case report IC (First phase)

This 8.3 year old female presented with a Class I dental pattern with moderate crowding in her upper and lower arches. Her lower arch showed wide mandibular basal bone with a moderately deep curve of Wilson. Her lower central incisors showed slight gingival recession.

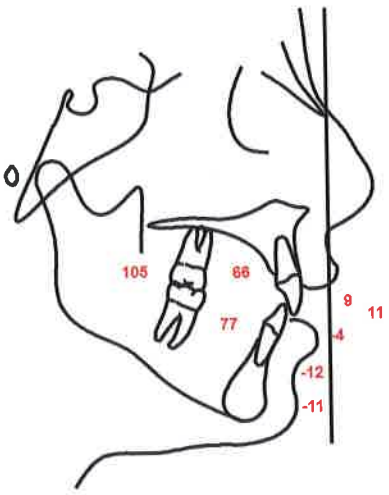
I.C.
BEGINNING
8.3 yrs



SNA 77°
SNB 71°
ANB 6°
A-N ⊥ FH 1 mm
Po-N ⊥ FH -11 mm
WITS 0 mm
GoGn SN 40°
FM 33°
MM 36°
↑1 to APo 5 mm
↓1 to APo 1 mm
↑1 to Max Plane 93°
↓1 to Mand Plane 84°

Fig. 7.12

I.C.
BEGINNING
8.3 yrs



↑ Incisor torque to occl. plane 66°
↑ Incisor tip to TVL -12 mm
↑ Lip thickness 13 mm
↑ Lip to TVL 3 mm

Max. anterior height 27 mm
↑ Lip length 18 mm
↑ Incisor exposure 9 mm
Inter-labial gap 11 mm

Occlusal plane to TVL 105°
↓ Incisor torque to occl. plane 77°
↓ Lip thickness 12 mm
↓ Lip to TVL -4 mm
Soft tissue 'B' point -12 mm
Soft tissue pogonion -11 mm

Fig. 7.13

Cephalometrically the patient showed a high mandibular plane angle and a steep occlusal plane (Figs. 7.12 & 7.13). The patient's upper and lower incisors were retroclined, reflecting the high angle pattern, and the chin was retrusive. The panoramic radiograph showed all teeth developing, except upper third molars, and suggested a restricted nasal airway, with probably associated mouth breathing.

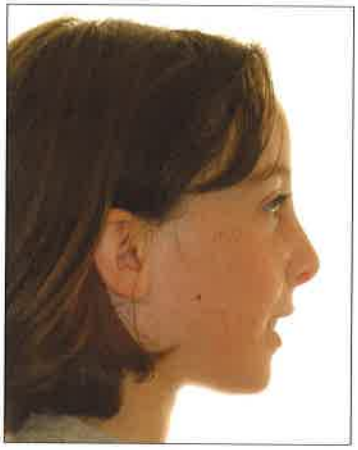


Fig. 7.14

Fig. 7.15

Fig. 7.16

Fig. 7.17

Fig. 7.18

Fig. 7.19

Fig. 7.20

Fig. 7.21

Fig. 7.22

During the first phase of treatment, a lower removable sagittal appliance was worn for uprighting of the mandibular posterior segments (Fig. 7.28). A rapid maxillary expansion (RME) appliance was used for upper arch widening.

Fig. 7.23

The RME produces skeletal change in the upper arch (Fig. 7.27). The widening is needed to compensate for the dental uprighting in the lower arch, and to avoid a crossbite (Fig. 7.26). If the upper arch is not widened skeletally in this way, later in treatment there may be insufficient bone to move upper molars buccally by dental movement. This will prevent correction of any crossbites which develop.

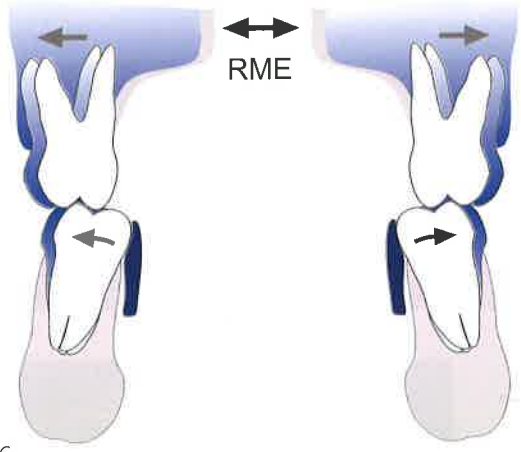


Fig. 7.26

After expansion was completed (Fig. 7.33), the upper width was held using a palatal bar with extension arms to the primary canines. The removable lower appliance provided 3 mm of widening and favorable torque change in the lower posterior segments.

An upper 2 x 4 appliance was placed for incisor alignment. The four links of elastomeric chain were pre-stretched before placement (Fig. 7.32) and very light forces were used, as the lateral incisor roots were close to the developing canine crowns at this stage.

There was gingival recession on the lower left central incisor (Figs. 7.30 & 7.31). Some spontaneous improvement in lower incisor alignment occurred (Fig. 7.34).

Fig. 7.29

Fig. 7.32. The four links of elastomeric chain was pre-stretched before placement and light forces were used, because the lateral incisor roots were close to the developing canine crowns at this stage.

Fig. 7.24

Fig. 7.25

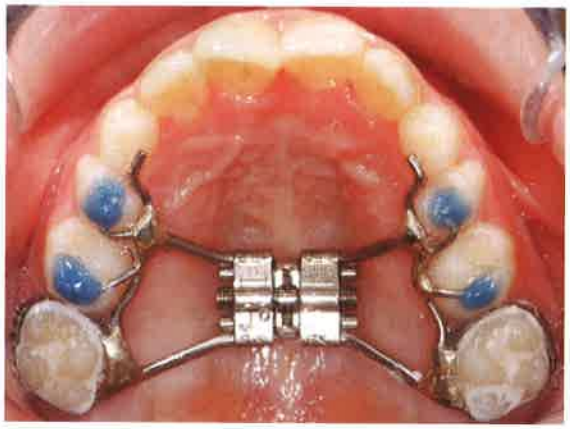


Fig. 7.27

Fig. 7.28

Fig. 7.30

Fig. 7.31

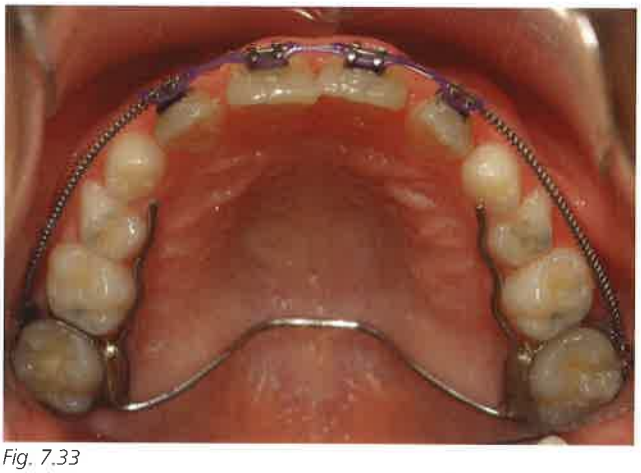


Fig. 7.33

Fig. 7.34

Case report IC (progress records)

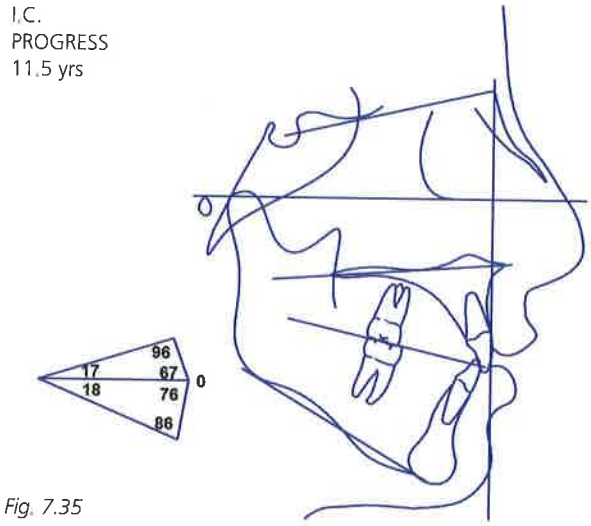


Fig. 7.35

SNA 77°
SNB 71°
ANB 6°
A-N ⊥ FH -1 mm
Po-N ⊥ FH -11 mm
WITS 0 mm
GoGn SN 41°
FM 31°
MM 35°
↑1 to APo 4 mm
↓1 to APo 1 mm
↑1 to Max Plane 96°
↓1 to Mand Plane 86°

Good expansion had been achieved during the first phase. Progress records were taken before starting the second phase of treatment at age 11 years 5 months.

The maxillary first molars were slightly over expanded which settled in very quickly. The second molars erupted slightly palatally (upper) and lingually (lower), compared with the position of the expanded first molars. The case shows minimal crowding in the lower anterior segment with continuing gingival recession of the lower left central incisor.

Fig. 7.39

Fig. 7.42. Progress panoramic radiograph.

Fig. 7.36

Fig. 7.37

Fig. 7.38

Fig. 7.40

Fig. 7.41

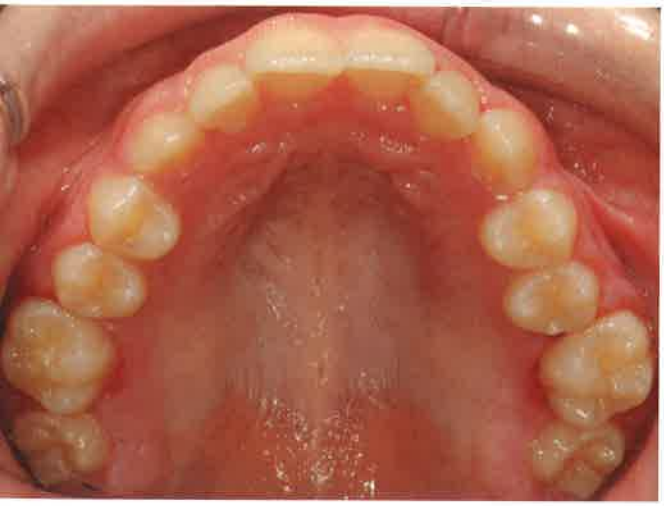


Fig. 7.43

Fig. 7.44

Case report IC (Second phase)

Upper and lower appliances were placed using indirect bonding. The upper right canine bracket was not placed initially because the tooth was not fully erupted. The normal .016 HANT wires were placed to start levelling and aligning.

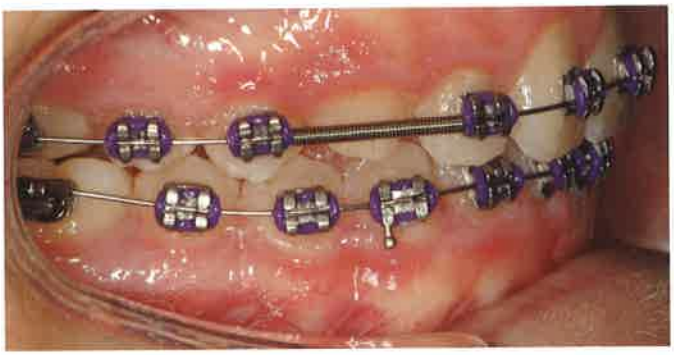


Fig. 7.45

Here the case is seen 3 months later. The upper right canine has been bracketed and an upper .016 HANT continues to be used. The lower arch has progressed to .019 x .025 HANT and a decision was made to invert the lower left central incisor bracket at the next appointment, before progressing to steel rectangular wires.

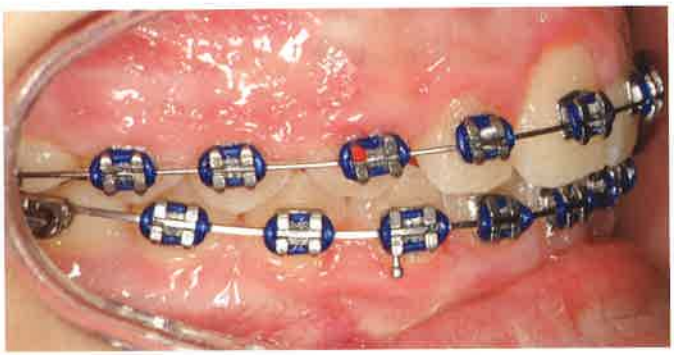


Fig. 7.48

The case is seen with upper and lower steel .019 / .025 posted steel wires in place. Active tiebacks were used to close minor spaces. The five guidelines for overbite control were followed (page 90) and levelling of the curve of Spee was achieved without the need for wire bending.

Before placement of these wires, the lower left central incisor bracket was inverted. This provided +6 ° of lingual root torque.

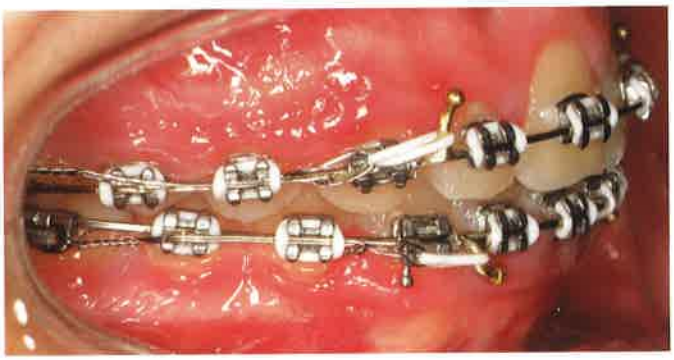


Fig. 7.51

For several years the authors have been using high performance .019 / .025 posted steel wires (Fig. 7.55). These have two advantages. First, they have posted ball hooks, which are more comfortable for the patient than the previous bare soldered hooks (Fig. 7.54). Second, they are heat treated and are more rigid for sliding mechanics and overbite control.

Fig. 7.54

Fig. 7.55

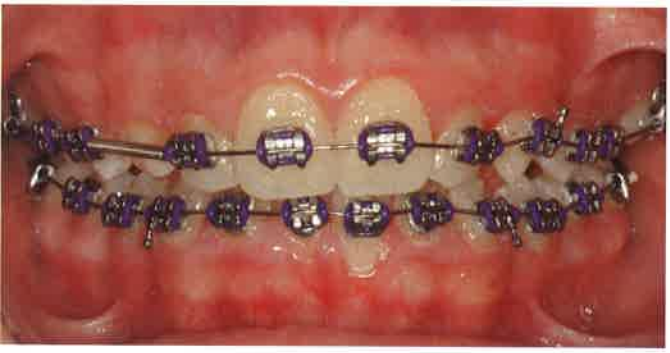


Fig. 7.46

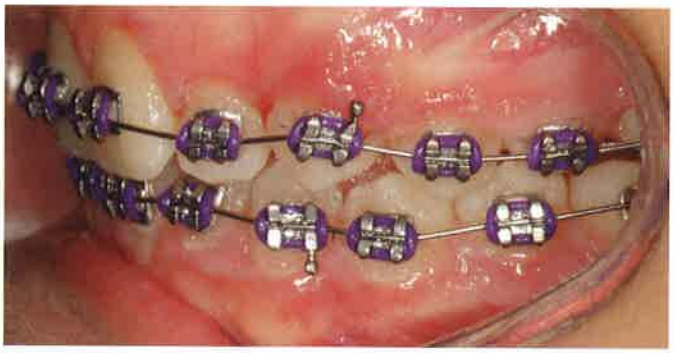


Fig. 7.47

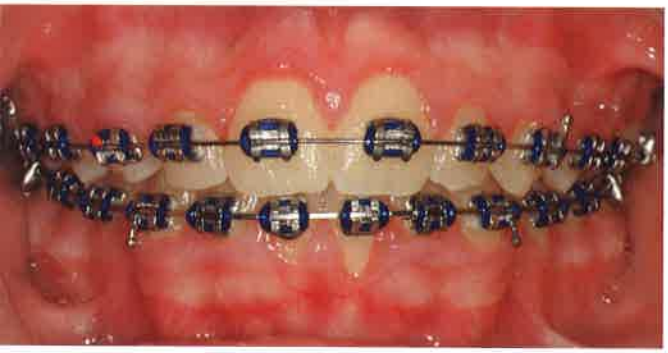


Fig. 7.49

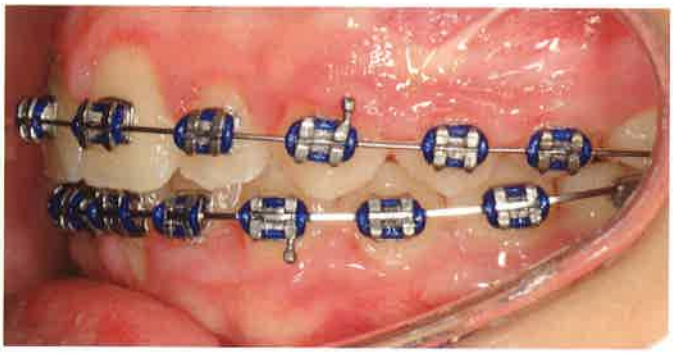


Fig. 7.50

Fig. 7.52

Fig. 7.53

Fig. 7.56

Fig. 7.57

Case report IC (Final records)

The final intra-oral photos show that a Class I occlusion with good arch form was achieved. The panoramic radiograph showed good parallelism of roots, and suggested an improved nasal airway, after the upper maxillary expansion. The lower left central incisor showed corrected torque and gingival condition.

The final facial photos and cephalometric radiograph showed good upper and lower incisor torque was achieved. The chin remained somewhat retrusive because of the steep occlusal plane, but overall facial balance was improved.

I.C.
FINAL
13.0 yrs

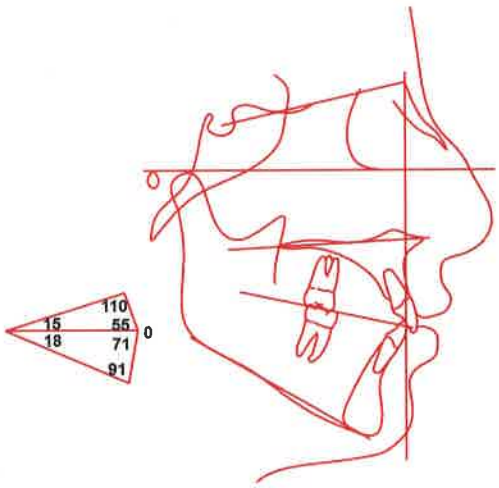


Fig. 7.58

SNA 77°
SNB 72°
ANB 5°
A-N ⊥ FH -1 mm
Po-N ⊥ FH -9 mm
WITS 0 mm
GoGn SN 40°
FM 30°
MM 33°
↑1 to APo 7 mm
↓1 to APo 4 mm
↑1 to Max Plane 110°
↓1 to Mand Plane 91°

I.C.
FINAL
13.0 yrs

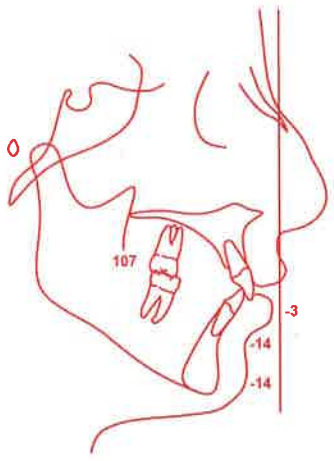


Fig. 7.59

↑ Incisor torque to occl. plane 52°
↑ Incisor tip to TVL -12 mm
↑ Lip thickness 15 mm
↑ Lip to TVL 2 mm

Max. anterior height 26 mm
↑ Lip length 20 mm
↑ Incisor exposure 6 mm
Inter-labial gap 4 mm

Occlusal plane to TVL 107°
↓ Incisor torque to occl. plane 67°
↓ Lip thickness 12 mm
↓ Lip to TVL -3 mm
Soft tissue 'B' point -14 mm
Soft tissue pogonion -14 mm

Summary

Due to the patient's broad mandibular basal bone, minimal uprighting helped widen the lower arch. Then maxillary expansion was effective in widening the upper arch to allow for eruption of the permanent dentition and relief of crowding.

Fig. 7.60

Fig. 7.61

Fig. 7.62

g. 7.63

Fig. 7.64

Fig. 7.65

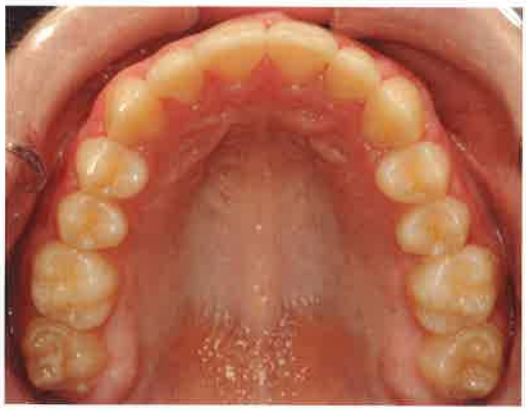


Fig. 7.66

Fig. 7.67

Fig. 7.68

CHAPTER 8

Anchorage control

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Anchorage control

Control of anchorage lies at the heart of good orthodontic care. It is necessary for the treatment objectives to be achieved, and for the tooth movements to be completed in a timely way (B1 p. 89) (B3 p. 93). Without anchorage control, some cases will not reach the planned treatment goals, and there will be extended treatment times. There is often a main focus on antero-posterior (A/P) control, but vertical and lateral control are also important, as will be seen.

Up to the time when the case reaches working .019 / .025 steel wires, anchorage control is needed to prevent the malocclusion from becoming worse, and possibly producing some improvement in incisor position.

After the working wires are placed, anchorage control is different. It is used to ensure that the incisors and the rest of the dentition are properly positioned in the facial complex at the end of treatment [1,2,3].

Planned incisor position (PIP)

A 'planned incisor position' is decided for every case (B3 p. 166) at the treatment planning stage, as the key starting point for the diagnosis and treatment planning process. It is a four stage process.

First, an ideal position (PIP) for the upper incisors is determined, for A/P position, torque, and vertical positioning (Fig. 8.01). Second, a plan is made for the lower incisors, when possible, to be positioned in good relationship to the PIP for the upper incisors (Fig. 8.02). Third, it is then decided how the rest of the lower teeth can be moved to be well aligned behind the planned lower incisor position. Fourth, a plan is made for the mechanics to fit the rest of the upper teeth to the PIP for the upper incisors. Crowding or spacing will need to be dealt with, using correct treatment mechanics.

The PIP is kept in mind throughout treatment. With good mechanics, the incisors will not, at any stage, move away from the PIP. Ideally, all tooth movements will leave the incisors unchanged or move them favorably towards the PIP treatment goal.

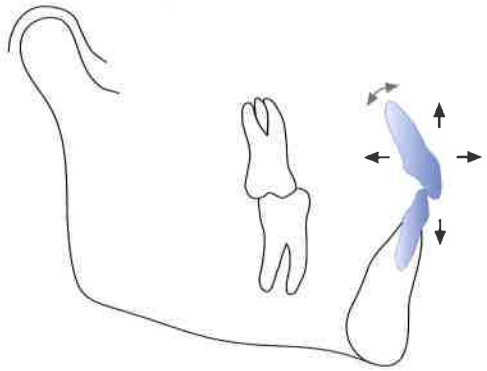

Fig. 8.01 At the treatment planning stage a planned incisor position (PIP) is decided for the upper incisors, for A/P position, torque, and vertical positioning. This establishes the treatment goal (orthodontic or sometimes surgical orthodontic). With good mechanics, the incisors will not, at any stage, move away from the planned goal.

Anchorage control during levelling and aligning

When starting an orthodontic case, levelling and aligning is normally the first objective. It has been previously discussed (B3 p.94) and is defined as follows:

> *The tooth movements needed to achieve passive engagement of a steel rectangular .019 / .025 wire of suitable arch form, into a correctly placed and accurately manufactured preadjusted .022 bracket system.*

Anchorage control is used to prevent unwanted tooth movements, away from PIP, during levelling and aligning (B3 p.94). In this way, the malocclusion does not become worse, and the incisors do not move away from the PIP, as the case progresses towards working wires.

Anchorage control with the working wires

When the case is in working wires, anchorage control is used to guide the anterior teeth towards their planned position, while preventing any unwanted tooth movements, away from PIP. This is discussed in detail later in this chapter.

Antero-posterior (A/P) anchorage during levelling and aligning

The aim is to control anchorage and move the malocclusion to working .019 / .025 steel wires, without any key features becoming worse.

Accordingly, in Class II/1 cases, the overjet should not increase (Fig. 8.02) and in Class III cases, the lower incisors should not move labially (Fig. 8.03). With bimaxillary protrusion cases, both upper and lower incisors need to be controlled (Fig. 8.04).

Light archwire forces are recommended, and a new wire should not be placed until the previous wire has served its purpose. It is an error to change wires too frequently, or to use elastomeric chain on light wires.

Bendbacks and lacebacks are essential in many cases. Bendbacks (B1 p. 14 & B3 p. 102) control arch length and restrict incisor labial movement. Lacebacks (B1 p. 15 & B3 p. 100) control and then retract canines in crowded cases after premolar extractions.

Some cases can be predicted to have high anchorage needs when the case gets to working wires, to move the incisors towards the PIP goal (Fig. 8.05). For these, molar control is needed during levelling and aligning, and a palatal or lingual arch can be placed at the start of treatment to restrict or prevent any mesial molar movement.

In the past, headgear was an option to support upper molar anchorage, sometimes with Class III elastics to assist lower anchorage also. Currently, headgear support is not considered in treatment plans because patients are unwilling to cooperate, and because temporary anchorage devices can often be used as a good alternative.

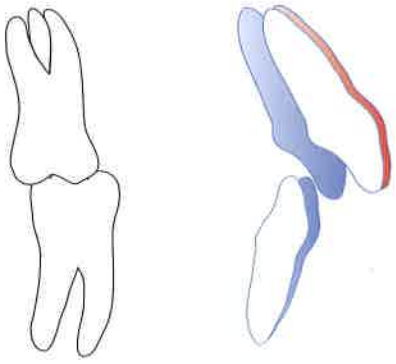

Fig. 8.02 With Class II/1 treatment, the upper incisors should not be allowed to move mesially (red). Control can be provided with light forces, bendbacks, lacebacks, and other measures.

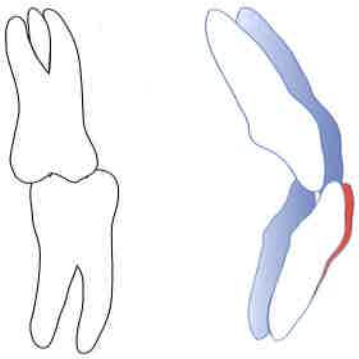

Fig. 8.03 In most Class III cases, the lower incisors should not be allowed to move mesially (red). It may be acceptable for the upper incisors to move a little mesially towards PIP.

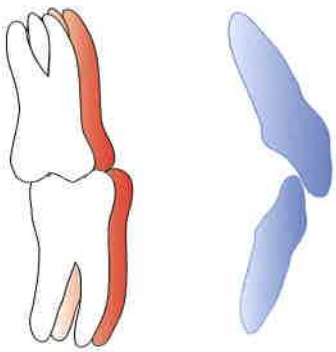

Fig. 8.05 In maximum anchorage cases the molars need to be prevented from mesial movement (red) during levelling and aligning, to ensure there will be enough anchorage later.

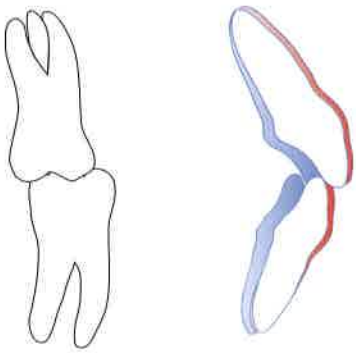

Fig. 8.04 In bimaxillary protrusion cases the upper and lower incisors are forwards from the PIP. Anchorage control, particularly bendbacks, are needed to prevent further protrusion (red).

Overbite control during levelling and aligning

In the early years with the straight wire appliance (SWA) heavy forces were applied, and elastomeric chains were used on light wires. The heavy forces and the tip in the brackets increased the curve of Spee and deepened the bite (Figs. 8.06 & 8.07) mainly in first premolar extraction cases, and it became known as the 'roller coaster' effect (B3 p. 98). This was also seen with the edgewise appliance by Tweed in extraction cases.

With the current mechanics there is less tip in the brackets, lacebacks are used, and forces are lighter, so the roller coaster effect is seldom seen in today's cases. However, careless mechanics, and excess force on light wires, can cause unwanted problems of this type.

Poor vertical control can also cause problems in cases with a reduced overbite (Figs. 8.08 and 8.09). During levelling and aligning there can be an unwanted opening of the bite, with incisors moving away from PIP. There are two areas where care is needed.

First, if there is any crowding in the case, space normally needs to be provided by premolar extractions or enamel reduction. Incisors will procline if attempts are made to resolve crowding without providing space, and the open bite will worsen.

Second, there is often a need to avoid including second molars at the start of treatment, otherwise there can be extrusion of first molars and a worsening of the open bite tendency. If second molars are included, the tubes should be bonded well to the occlusal. Light forces are particularly important, and the use of Class II elastics needs to be minimized.

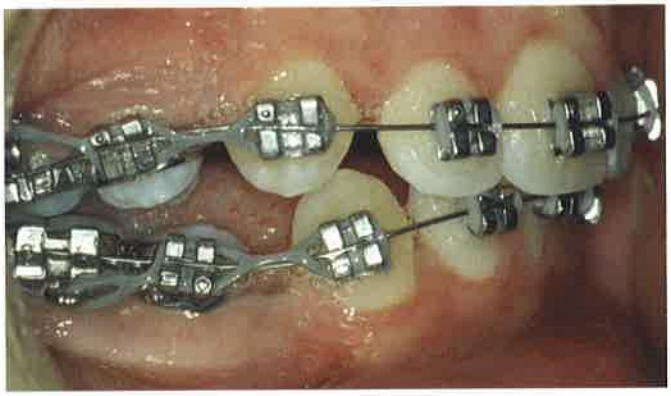

Fig. 8.06 The 'roller coaster' effect was seen with standard edgewise, and the term has been used since the early days with the preadjusted appliance. It describes unwanted deepening of the overbite, caused by incorrect mechanics.

Fig. 8.08 This crowded case (page 223) has a reduced overbite. Such cases require proper management of crowding, and attempts to align the teeth without space available will normally lead to a worsening of the anterior open bite tendency.

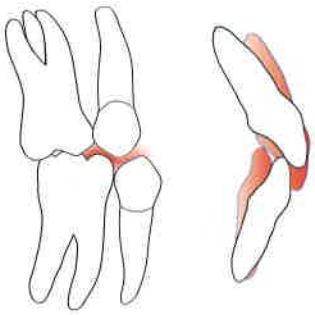

Fig. 8.07 Unwanted deepening of the overbite, with a lateral open bite, are signs that the treatment is not going well. There will be round tripping of teeth, and progress will be delayed while the case is brought back under control.

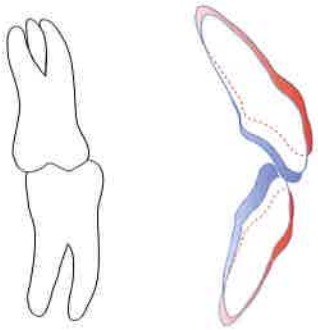

Fig. 8.09 Errors in treatment planning or the use of incorrect mechanics can cause an anterior open bite to develop. The incisors move away from the PIP, seen in blue, and there is loss of vertical anchorage.

ocal vertical control during levelling nd aligning

n the early stages of treatment, high labial canines can be osely tied to the opening .016 HANT wire (B3 p. 107). This ill avoid unwanted vertical movement of lateral incisors and remolars (Fig. 8.10). If necessary a laceback can also be used o guide the canine distally towards the extraction site.

f there is no treatment, high canines tend to erupt without ssistance and be guided into good position by the oral nusculature. It can be an error to fully engage the wire into ne canine bracket slot (Fig. 8.11) as there will be vertical novement of the adjacent lateral incisor and premolar, away rom PIP.

ig. 8.10 In this case a 'lasso' elastomeric module is being used to lightly ngage a .016 HANT wire on to the upper right canine bracket. his avoids intrusion and round tripping of the second premolar and the ateral incisor. If necessary, a laceback can also be used to guide the rown distally. Photograph courtesy of Dr. Anne-Marie Nafash.

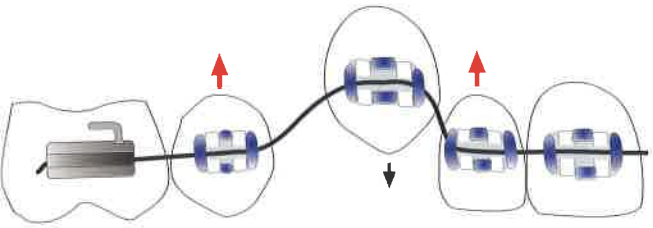

Fig. 8.11 If teeth are a long way from the line of the arch vertically, it is an error to attempt rapid alignment. The wire distorts and loses its form, and there is a risk of round tripping the nearby teeth. In this illustration, adjacent second premolars and lateral incisors will tend to intrude, and will need to be extruded later in treatment.

Loss of lateral and A/P anchorage control during levelling and aligning

Correct decisions should be made when treatment planning, to properly manage lower arch crowding, and the appropriate ovoid, tapered or square arch form should be used for levelling and aligning. If errors are made, there will be a loss of lateral anchorage (Fig. 8.12).

The options for managing lower arch crowding are discussed in chapters 9 and 10. If the crowding is greater than can be managed by appropriate IPR and reasonable dental compensation, extraction treatment is indicated. It is an error to attempt treatment without taking one of these steps to manage crowding, as loss of lower arch anchorage will occur (Fig. 8.12). Some cases will not reach the planned treatment goals, or there will be extended treatment times, or round tripping.

The correct arch form should be used. If a square form is used to level and align the teeth of a patient with a tapered lower arch, there will be consequences in some cases. The loss of lateral anchorage control during levelling and aligning will often lead to instability or poor aesthetics.

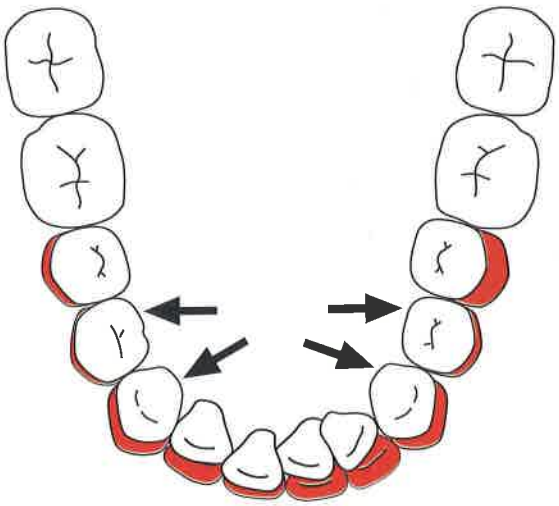

Fig. 8.12 During levelling and aligning the correct management of crowding and choice of arch form is needed, otherwise there will be a loss of lateral and A/P anchorage (red) in the lower arch in many cases. Such errors will bring a risk of extended treatment times or round tripping, and many cases will not reach the planned treatment goals.

Temporary anchorage devices (TADs)

The late 1990s and early 2000s saw the introduction of devices to obtain skeletal anchorage directly from bone. The terminology has taken some time to become standardized, and continues to be a little confusing. However, the overall term 'temporary anchorage device' or 'TAD' can be used to include the various types of miniscrews, midpalatal implants and short osseointegrated implants which are available.

It is beyond the scope of this book to give detailed advice and recommendations about the use of TADs, and the reader is referred to the book by Dr. Paik and co-authors [4]. This excellent text covers the subject, with a special focus on the use of orthodontic miniscrew implants, and many of the treated cases use the mechanics described in this book (Fig. 8.13).

In the past, when a new technique has become available in orthodontics, it has been greeted with enthusiasm as a breakthrough, and this is followed by overuse. This has tended to happen with TADs, and early claims were made that they would prevent undesirable tooth movements in both arches [7]. However, over time it has become clear that they are not a panacea, or a substitute for good treatment planning, followed by correct mechanics.

The development and refinement of TADs is a 'work in progress' as the knowledge and experience accumulates on the use of various types. Some, such as onplants, have not seen widespread use. They were suggested as titanium alloy disks, to be inserted subperiosteally, and osseointegrated to the bone surface [8].

Midpalatal implants [9] have been suggested and used, but they have disadvantages. They are a suitable source of anchorage from bone, but are rather complex and expensive, compared with other options. They need skilled surgical placement to avoid the roots of nearby teeth, and when in situ, their position is not always ideal to support a palatal bar.

The authors have found that TADs can be used selectively, and they offer a good option in some cases, where there is a need for total anchorage support from adjacent bone.

Concerning miniscrew implants, one author (JB) has treated mainly children for the past 15 years and has limited experience with TADs, having used normal mechanics with conventional anchorage support in most cases. The other author (RMcL) has had a mixed experience with miniscrew implants. Some cases have gone well, but there have been a few issues with implants becoming loose, and being replaced, which is a cause for patient disappointment.

Orthodontic miniscrew implants can be used at various stages in the treatment [4,11]. They can serve to anchor molars during levelling and aligning (Fig. 8.14) or they can support the use of elastics or coil springs during sliding mechanics (Figs. 8.15 – 8.18).

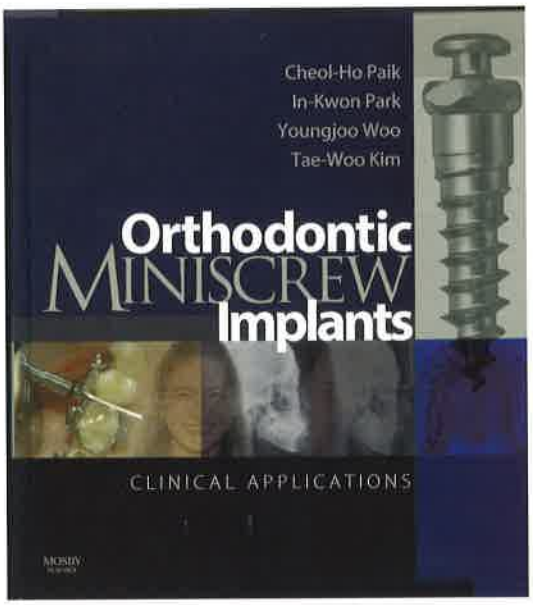

Fig. 8.13 The excellent text by Dr. Paik and co-authors covers the subject of TADs, with a special focus on the use of orthodontic miniscrew implants. Many of the treated cases use the mechanics recommended in this book.

Fig. 8.14 Miniscrew implants are an option in cases where there is need for total anchorage support from adjacent bone. In the authors' experience they work well in some cases, but on occasion they can become loose. Here, a TAD is being used to anchor a lower molar during levelling and aligning.

Fig. 8.15 The authors are grateful to Dr. Hiroki Hayashi for images of this severe Class II/1 case. The patient did not want surgery, and it was decided to extract upper first premolars and a lower incisor, accepting a Class II molar relationship.

Fig. 8.16 Miniscrew implants were used to obtain total anchorage support from adjacent bone. Here the case has reached a working steel .019 / .025 upper wire, and sliding mechanics are supported by TADs bilaterally.

Fig. 8.17 The case at the end of space closure.

Fig. 8.18 Dr. Hiroki Hayashi's case after appliance removal.

Surgical anchorage plates

In cases where absolute anchorage is needed, surgical plates have proved to be a reliable and effective option for the authors. They are more invasive than TADs, as they require a surgical flap before placement. This is almost exclusively done by oral surgeons, who are generally quite good at placing plates. Plates are normally reliable and their failure rate is less than TADs. Unlike TADs, which are normally removed after they have served their purpose, plates will sometimes osseo-integrate and are frequently left in place. After they have served their purpose, the extensions used for the orthodontic attachments are removed, and generally the area heals over nicely. Two clinical examples are shown at the end of this chapter. The first case shows a standard surgical plate and the second case shows a 'Bollard' type plate, developed by Dr. Hugo De Clerck.

The De Clerck Bollard plate (Fig. 8.19) has been reported as being particularly effective for cases needing bone anchored maxillary protrusion [5], with the plates giving a success rate of 97%. It was noted that success depends on proper patient advice, minimal invasive surgery, good post surgical instructions, and appropriate orthodontic follow-up [6].

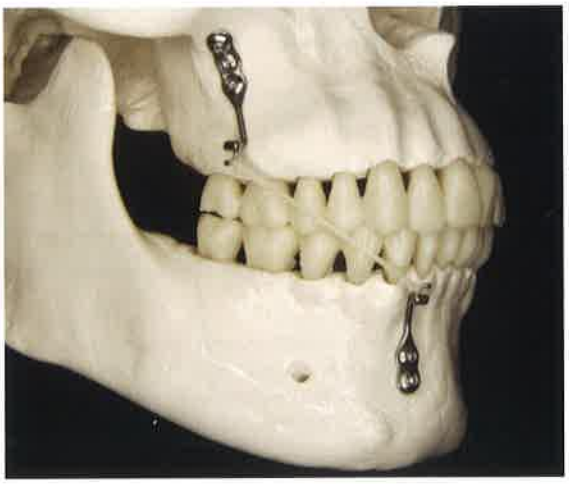

Fig. 8.19 The plated type of TAD, as described by De Clerck, is a reliable and effective option. The success rate is reported to be high. This method can be used to support orthodontic tooth movements, or for inter maxillary traction, particularly for cases needing maxillary protraction. The authors are grateful to Dr. De Clerck for the use of this image.

Reciprocal anchorage with working wires

With the arrival of the preadjusted edgewise appliance, level slot line up became possible (B1 p. 25) along with sliding mechanics. For the first time, groups of teeth could be moved in a planned way, and the orthodontist was better able to control the patient's profile.

During space closure with sliding mechanics there is individual variation in the anchorage balance and the rate of tooth movement. The recommended space closure method (Figs. 8.21 – 8.23) has been used for many years and tooth movements normally go along uneventfully. There are known reasons for a slow rate of space closure, and possible obstacles have been previously reviewed (B3 p. 259). Many cases can be well treated using reciprocal space closure, without the need for mechanics to change the anchorage balance.

When closing first premolar extraction space, the balance is normally reciprocal in the lower arch, which is about 50:50. In the maxilla, the balance is often 50:50 but can sometimes be closer to 60:40 in favor of mesial molar movement. This may be because the combined upper incisor and canine root area is larger than in the lower, and the maxillary bone is more amenable to molar movement. It may sometimes be due to torque issues among the upper incisors. If the upper molar moves mesially more rapidly than the lower, the molar relationship will be lost as space closes. It is often helpful to ask the patient to wear night time Class II elastics to maintain molar relationship (Fig. 8.20).

It is a mistake to apply excessive force, because unwanted tooth movements will occur (B3 p.252) with loss of anchorage due to hyalinization. The excess force is insufficient to cause hyalinization around the larger root areas of the posterior teeth, which continue to move mesially. The incisors have a smaller root area and hyalinization can prevent movement.

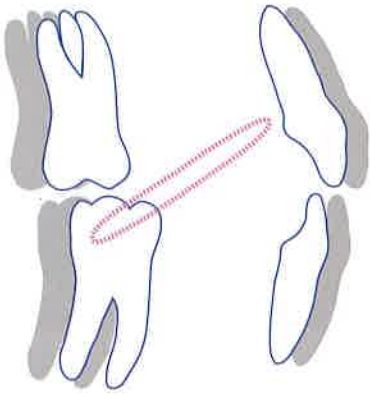

Fig. 8.20 During reciprocal space closure, night time Class II elastics can be helpful to maintain the molar relationship.

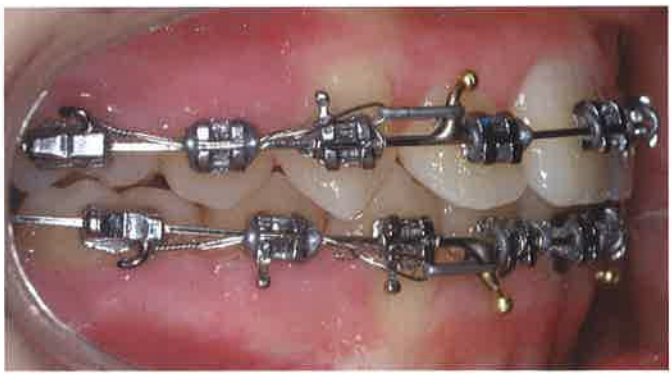

Fig. 8.21 A case at the end of space closure. Active tiebacks are in place on high performance steel wires, with soldered ball hooks for patient comfort. Elastomeric modules are stretched to twice their resting size, as recommended.

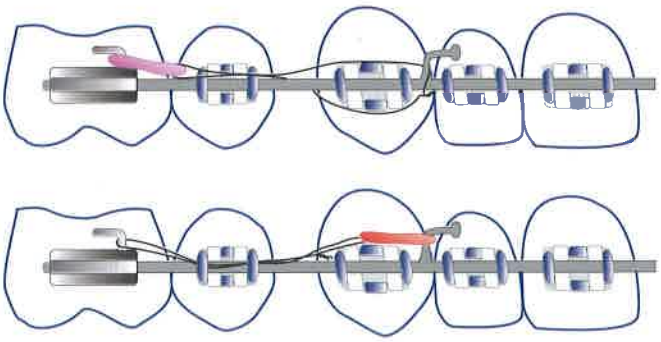

Fig. 8.22 Space closure mechanics with an active tieback. The elastomeric module is stretched to twice its resting size from the molar hook. A high performance .019 / .025 steel wire is in place, with soldered ball hooks. The wire ends are tucked below the archwire, to keep them clear of Class II elastics and for patient comfort.

Fig. 8.23 Alternative space closure mechanics with an active tieback. The elastomeric module is stretched to twice its resting size from the archwire hook. It is important to have a small amount of arch wire protruding distally to the molar tube with both methods.

Minimal anchorage cases

The anchorage needs of cases varies from minimum to maximum. When crowding is greater than can be managed by appropriate IPR and reasonable dental compensation, extraction treatment is indicated. It helps if cases with minimal anchorage needs are recognized at the treatment planning stage, and these cases normally require mesial movement of molars at some stage in the treatment (Fig. 8.24). Second premolar extraction should be considered, as this has long been regarded as a good option for 'borderline' extraction situations with little crowding [10]. If second premolars are extracted, there are eight teeth in front of the extraction sites, rather than the six teeth after first premolar extractions (Figs. 8.25 & 8.27). This anchorage balance will encourage mesial movement of molars. There is normally a need to start levelling and aligning without delay, and the treatment mechanics are discussed in chapter 11.

At the working wire stage, molars need to be encouraged to move mesially, to avoid over-retraction of the incisors in these cases (Fig. 8.24). Normal sliding mechanics will work well in most routine situations, as the molars tend to move mesially without over-retraction of the incisors, particularly in high angle cases. It can be helpful to add torque to the working wires (Fig. 8.26), and in extreme situations TADs or a reverse headgear can be considered to lose anchorage and preserve the profile. Inversion of lower incisor brackets can be a useful option in some cases, to prevent over retraction of the lower incisors (chapter 5).

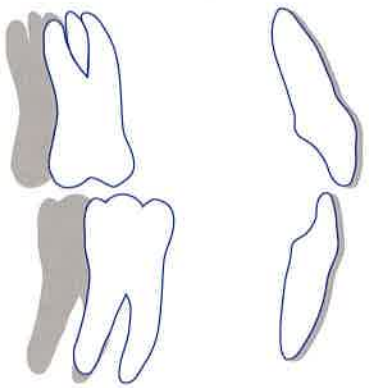

Fig. 8.24 Minimal anchorage cases normally require mesial movement of molars at some stage in the treatment.

Fig. 8.25 Second premolars are often a good extraction choice in minimum anchorage situations (Case NH page 222).

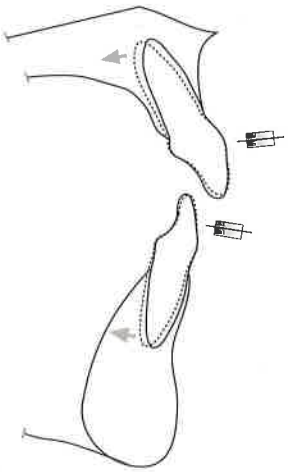

Fig. 8.26 It can be helpful to add torque to the working wires in minimal anchorage situations. After the addition of palatal root torque in the upper, and lingual root torque in the lower, the incisors are more resistant to retraction.

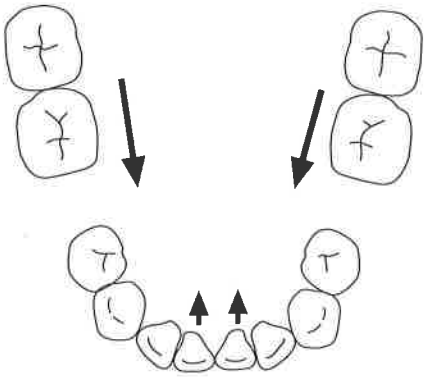

Fig. 8.27 During treatment planning it can be assumed that there is less anchorage from second premolar extractions, provided treatment is started without delay (Chapter 11).

Maximum anchorage with working wires

Maximum anchorage needs should be anticipated during treatment planning, and if extractions are needed, first premolars are normally selected (Fig. 8.28).

For severe bimaxillary protrusion cases, where extractions are needed, upper and lower first premolars will be considered. In Class III cases, the extraction choice may be upper second premolars and lower first premolars, to anticipate and balance anchorage needs. Conversely, if extracting in a Class II/1 case, sometimes upper first premolars and lower second premolars can be a helpful choice.

Earlier in the treatment, palatal and lingual bars are often used to support anchorage, as teeth align. However, lingual bars are of little use during sliding mechanics, because the teeth or soft tissue impinge on the wire. Palatal bars can be used to help anchorage balance during the early stages of upper incisor retraction, or support Class III elastics for lower incisor retraction.

Few of the present generation of patients will wear headgear to support anchorage, and the authors rely on other methods.

Properly used, Class II elastics are a potent source of anchorage support for upper incisor retraction in Class II/1 cases. This should not be overlooked (Fig. 8.29). If a full thickness .021 / .025 steel wire is tied in, the well aligned lower arch behaves like a giant multi-rooted tooth. With careful mechanics, light Class II elastics will not move the teeth off the dental base, and the lower incisors will not procline unduly, due to the -6° torque in the brackets.

Where possible, upper incisor torque control should be maintained, for aesthetic reasons, and not reduced to assist in overjet reduction in Class II/1 cases. However, in Class III cases lower incisor retroclination is an accepted dental compensation. Lower incisor retraction can be assisted by changing the anterior torque control in the incisor region. It is possible to thin the rectangular wire in the lower incisor region, or add lingual crown torque for the lower incisors (Fig. 8.30). Switching left and right lower canine brackets (page 61) also allows easier retraction of lower incisors.

As discussed earlier, TADs can be used in situations where absolute anchorage is needed. This can be unilateral (Case ES page 116) or bilateral, depending on the needs of the case.

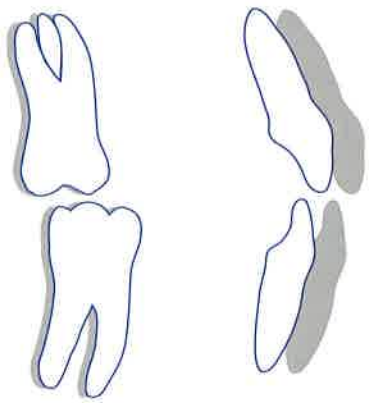

Fig. 8.28 Maximum anchorage cases involve incisor retraction in one or both arches, and molar control. If extractions are needed, first premolars are normally selected.

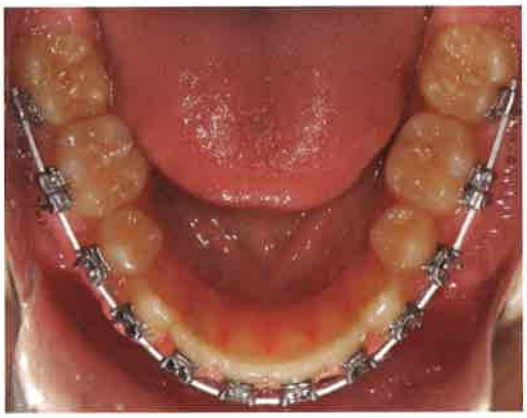

Fig. 8.29 A full thickness .021 / .025 steel wire can be tied in. The lower arch behaves like a giant multi-rooted tooth, and provides ample anchorage for light Class II elastics. With careful mechanics, lower teeth will not move off the dental base, and the lower incisors will not procline unduly, due to the -6° torque in the brackets.

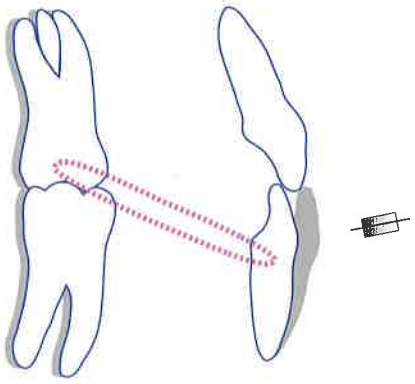

Fig. 8.30 Lower incisor retraction can be assisted by adding lingual crown torque and using Class III elastics.

PREVIOUS BOOKS

B1 Bennett J, McLaughlin RP. 1993 Orthodontic treatment mechanics and the preadjusted appliance. Mosby-Wolfe, London ISBN 0 7235 1906X

B2 Bennett J, McLaughlin RP. 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford ISBN 1 899066 91 8. Republished in 2002 by Mosby, Edinburgh ISBN 07234 32651

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Case ES Treatment sequence

This case shows anchorage control in the upper left quadrant and the lower anterior area, and treatment is continuing as the book goes to press. This 29.1 year old female presented with a Class I dental relationship and a slightly retrusive chin. Frontally, the face was symmetrical, but dentally the upper midline was off to the right, due to the early extraction of an upper right premolar, and the upper right canine was in a Class III relationship. There was moderate to severe crowding in the lower arch, and the crowns of the upper and lower incisors were triangular in shape.

E.S.
BEGINNING
29.1 yrs

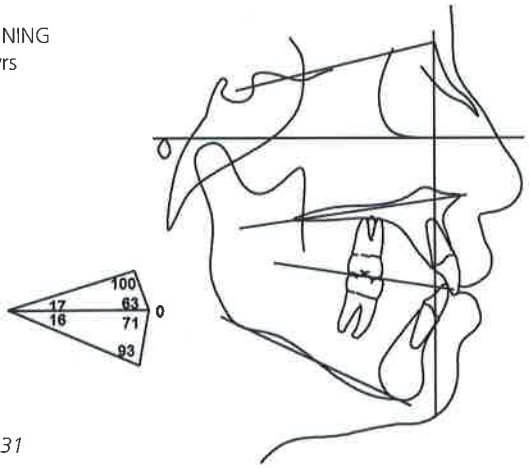


Fig. 8.31

SNA 79°
SNB 74°
ANB 5°
A-N ⊥ FH 3 mm
Po-N ⊥ FH -4 mm
WITS 0 mm
GoGn SN 35°
FM 25°
MM 33°
↑1 to APo 7 mm
↓1 to APo 4 mm
↑1 to Max Plane 100°
↓1 to Mand Plane 93°

E.S
BEGINNING
29.1 yrs

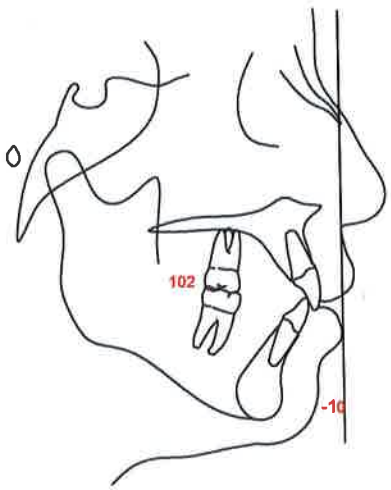


Fig. 8.32

↑ Incisor torque to occl. plane 60°
↑ Incisor tip to TVL -9 mm
↑ Lip thickness 14 mm
↑ Lip to TVL 4 mm

Max. anterior height 28 mm
↑ Lip length 25 mm
↑ Incisor exposure 3 mm
Inter-labial gap 3 mm

Occlusal plane to TVL 102°
↓ Incisor torque to occl. plane 68°
↓ Lip thickness 13 mm
↓ Lip to TVL -1 mm
Soft tissue 'B' point -8 mm
Soft tissue pogonion -10 mm

Cephalometrically, the patient showed a mildly protrusive upper lip, with a slightly retrusive chin, due to a steep occlusal plane angle of 102°. There was a long lower facial height. The panoramic radiograph showed a healthy dentition with some interproximal bone loss. Third molars were absent, and the condyles appeared to be healthy.

Fig. 8.33

Fig. 8.34

Fig. 8.35

Fig. 8.36

Fig. 8.37

Fig. 8.38

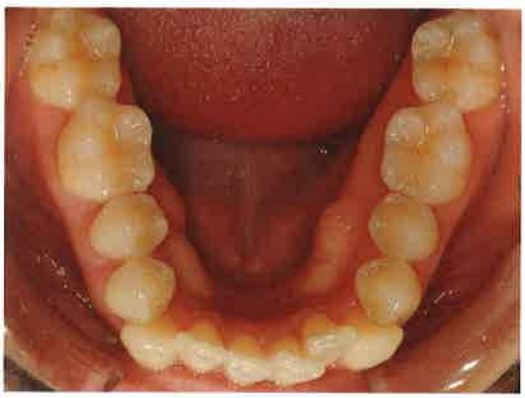


Fig. 8.39

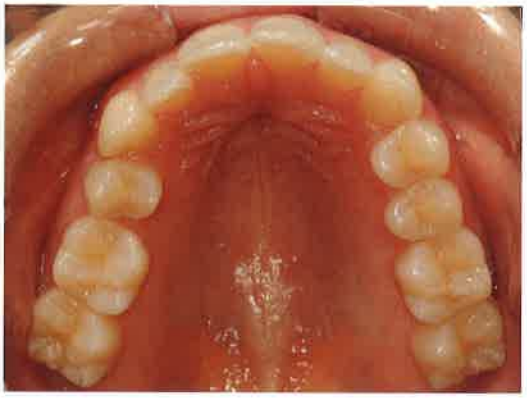


Fig. 8.40

Fig. 8.41

Lower first premolars and the upper left first premolar were extracted. The lower arch required moderate anchorage control, so a lingual arch of .045 round wire was placed. Brackets were placed passively under the wire on the lower central incisors with additional adhesive under the brackets. There was no attempt to align the lower central incisors at this stage, and they were included only to support the archwire. This allowed the use of a heavier lower wire early in treatment, without waiting for incisor alignment, to minimize lower canine tipping. Initial .016 HANT wires were placed, with lacebacks for canine control and retraction. Passive open coil springs were used in the lower lateral incisor areas for lip comfort.

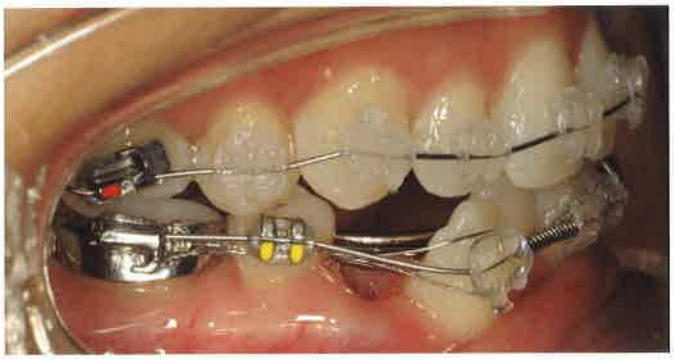


Fig. 8.42

The upper midline was 3 mm to the right of the center of the face. From the occlusal view (Fig. 8.46) and the starting panoramic radiograph (Fig. 8.41) the rotation and tipping of the upper right first molar and first premolar was evident, after the previous extraction of the upper right second premolar (Fig. 8.45). The upper right canine was tipped distally, and was expected to have a mesializing force as it aligned, which would assist in midline correction. The upper left canine crown was controlled with a laceback. Turbos were placed on upper first molars to avoid the risk of anterior enamel or bracket damage. Ideally, second molar turbos should also have been placed to avoid extrusion of these teeth. The upper left quadrant required maximum anchorage, and a plate was inserted at the time of premolar extractions, to support tooth movements (Fig. 8.51).

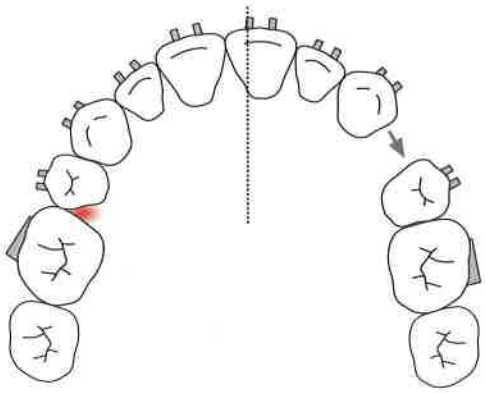


Fig. 8.45

Fig. 8.48

Upper and lower bendbacks were used for A/P anchorage control, with lacebacks in three quadrants. At the first adjustment visit, steel .014 arch wires were placed, and lacebacks were continued (Figs. 8.48 to 8.53). No attempt was made to align lower incisors until space was available after canine retraction. Light lingual elastomeric chains were used to help in rotation control as the canines moved distally. There is a lack of friction on the lingual side of extraction areas, and chains should only be used in this way every third visit, to avoid tipping and over-rotation.

Fig. 8.51

Fig. 8.43

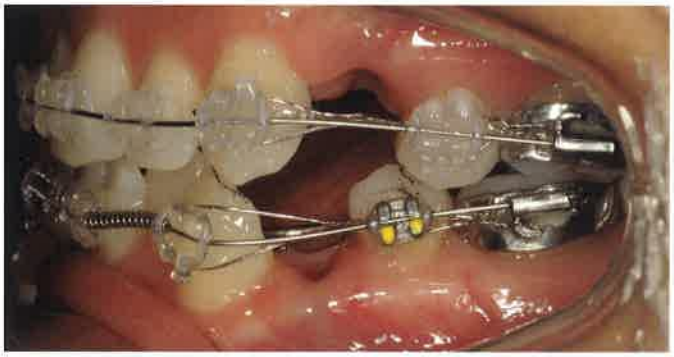


Fig. 8.44

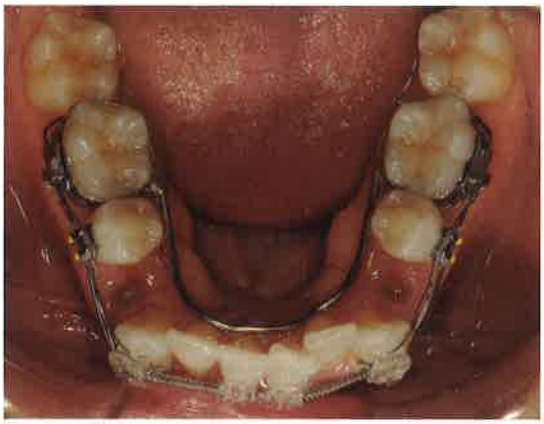


Fig. 8.46

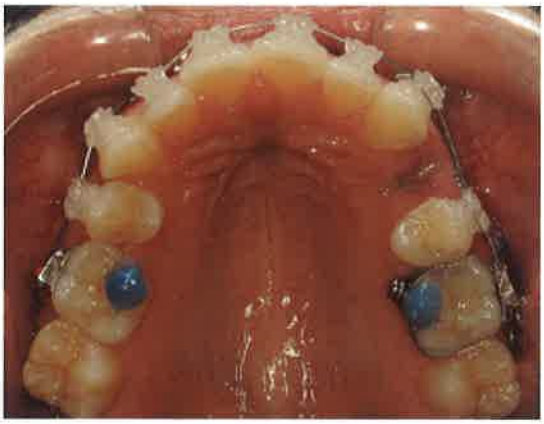


Fig. 8.47

Fig. 8.49

Fig. 8.50

Fig. 8.52

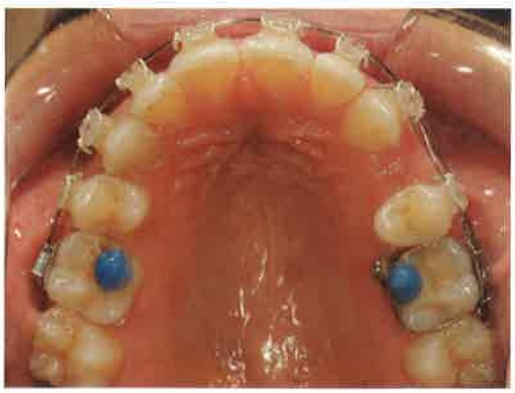


Fig. 8.53

An upper heat treated .020 steel wire is in place, which is ideal for canine retraction in a first premolar extraction case. As the root tip of the upper left canine gradually corrects, retraction will begin (Figs. 8.56 & 8.57). It is important to progress slowly through the arch wires in the early months, to allow this to happen. In the lower arch, space is now available and brackets have been placed on lower lateral incisors. A lower .016 HANT wire is in place.

The progress radiograph shows bodily movement of the upper left canine, and improved root positions in the upper right quadrant (Fig. 8.57). The laceback immediately tips the canine a small amount when first placed, compressing the periodontal space a little (Fig. 8.58). When the arch wire is placed, it begins uprighting the canine for 4 to 6 weeks. As an alternative to TADS, plates can be helpful in some cases, and there are many different types. A KLS Martin plate was used here (Fig. 8.51). Plates can help anchorage horizontally and vertically, depending on where they are attached. In this case, a ligature wire was tied from the lower loop of the plate to hold the molar in place while the canine was retracted, to support horizontal anchorage (Fig. 8.59 & 8.63). Turbos were added to the upper second molars at this stage, and lower second molar tubes were bonded. The steel .020 wire continued in the upper, and a .019 / .025 HANT wire was placed in the lower arch. The upper midline showed improvement (Fig. 8.61) as the upper left canine moved distally, and no anchorage was lost because of the support of the plate.

Fig. 8.54

Fig. 8.57

Fig. 8.60

The rotations of the upper right first molar and first premolar were improving in response to light forces and a correctly positioned appliance The lower lingual arch was removed (Figs. 8.63, 8.64 & 8.65).

This is the time when rectangular heat treated steel wires are coordinated with a wax template compressed on the lower brackets (Chapter 7). Turbos were being slightly reduced as anterior bracket contacts reduced.

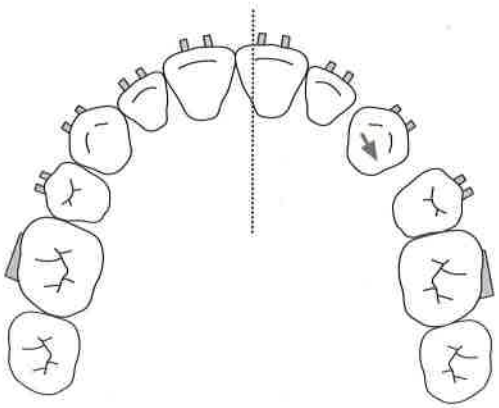


Fig. 8.63 The midline improves as the incisors drift to the left when the upper left canine is retracted by the laceback.

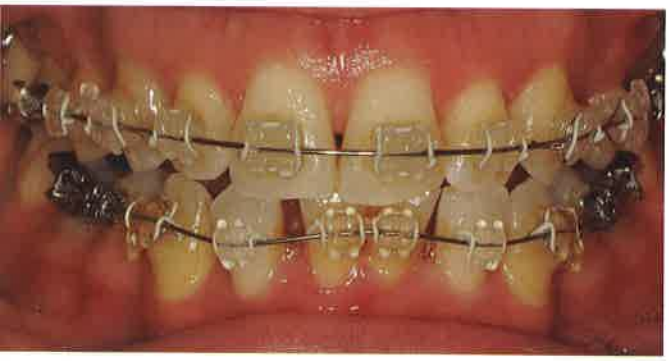


Fig. 8.55

Fig. 8.56

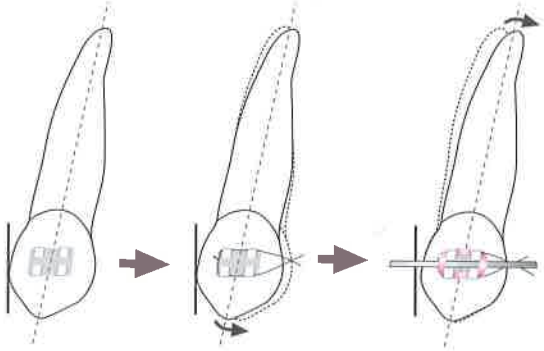


Fig. 8.58 The laceback effect in canine control. As the root tip of the canine gradually corrects, retraction will begin.

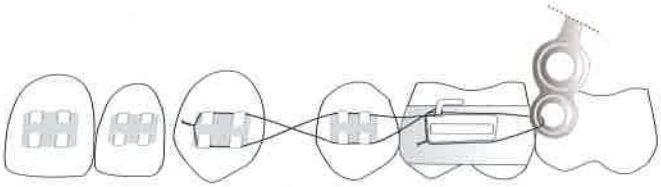


Fig. 8.59 A ligature wire tied from the loop of the plate to hold the molar and to support horizontal anchorage.

Fig. 8.61

Fig. 8.62

Fig. 8.64

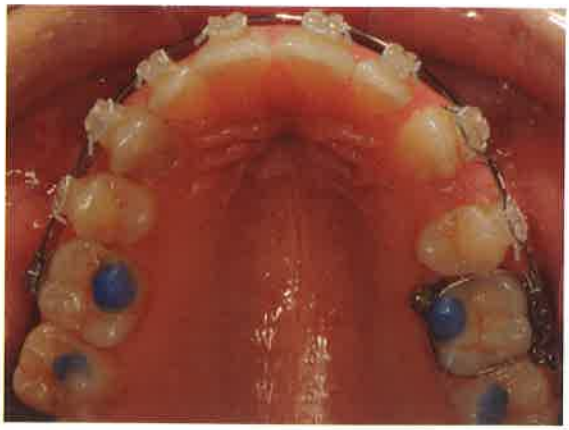


Fig. 8.65

Case ES Final images in the treatment sequence

Recent progress facial photos confirm that good facial balance was maintained during levelling and aligning, because anchorage was well controlled, and lower incisors were not allowed to procline.

Intra-orally, occlusal photos show the good arch alignment and symmetry from the rectangular steel working wires (Fig. 8.73 & 8.74) and confirm the benefits of using an efficient and organized method of arch form management (chapter 7).

This is a systemized approach to orthodontics, and a big advantage is that almost all cases reach working wires, after which they can be managed in a standard way. This case is slightly unusual, but it is now in working wires, and can be finished using the same methods as with other cases. Space closure is progressing well. There is no space remaining on the right side, and the posterior occlusion is 1mm Class II. The upper midline is only 1mm to the right and the lower midline is correct. On the left side, there is 1mm of space in the lower left quadrant, and 2.5 mm of space in the upper left quadrant. Light active tiebacks are being used for space closure. The ligature wire from the plate loop to the left first molar has been removed, as anchorage control is no longer needed in the quadrant.

Looking ahead, the lower incisors would benefit from some IPR and slight retraction. The upper central incisors require reshaping, to make them less triangular and avoid black triangles. Some additional torque will be needed, as the upper incisors are at 97° to the maxillary plane at present, and this will increase the overjet slightly. This in turn will allow the use of Class II elastics for correction of the posterior segments to a Class I relationship. The case should then progress uneventfully to finishing and settling (chapter 12).

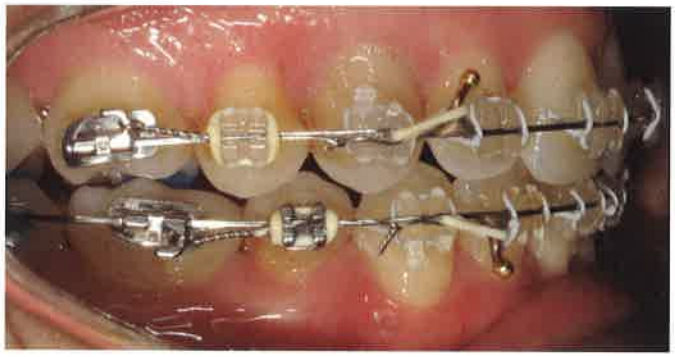


Fig. 8.70

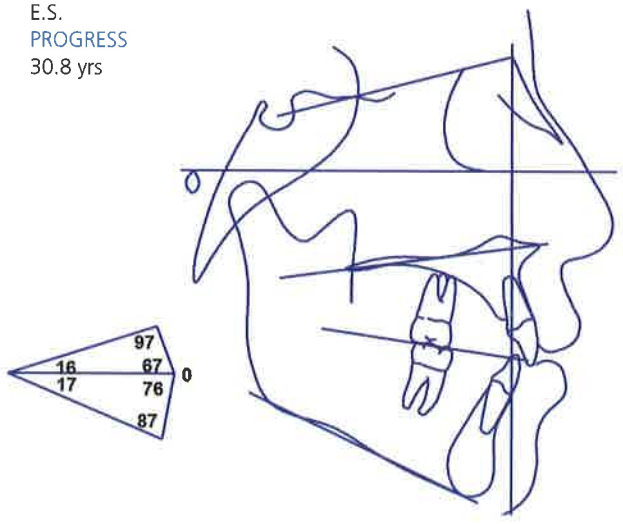


Fig. 8.66 The progress cephalometric tracing showed little change from the beginning tracing, other than slight retraction of the incisors.

SNA 78°
SNB 73°
ANB 5°
A-N ⊥ FH 2 mm
Po-N ⊥ FH -5 mm
WITS 0 mm
GoGn SN 36°
FM 25°
MM 33°
↑1 to APo 7 mm
↓1 to APo 2 mm
↑1 to Max Plane 97°
↓1 to Mand Plane 87°

Fig. 8.67

Fig. 8.68

Fig. 8.69

Fig. 8.71

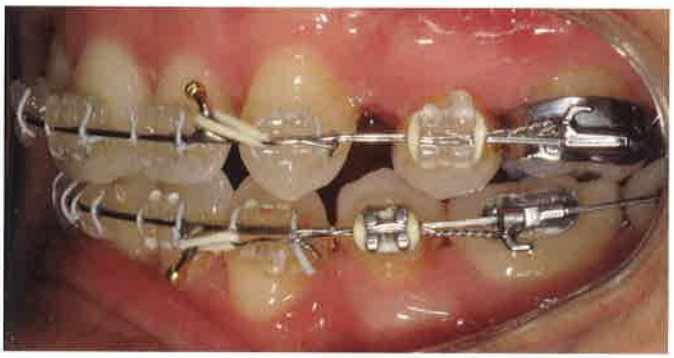


Fig. 8.72

Fig. 8.73

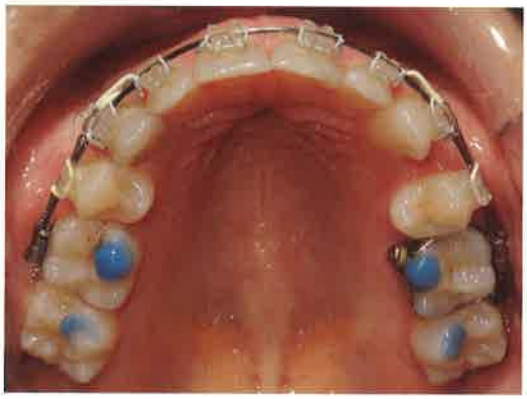


Fig. 8.74

Summary

This extraction case shows the advantage of using an intra-oral anchorage plate in the upper left 'maximum anchorage' quadrant. The plate was placed at the time of the premolar extractions. There was very little discomfort post-surgically, and the plate was stable during the entire time of treatment. In the lower arch, anchorage was controlled with the support of a lingual arch. Canines were retracted with lacebacks, to make space before attempting to align the lower incisors.

Case report AY (First phase)

This 6.11 year old male presented in the early mixed dentition stage, with a pseudo Class III dental relationship when in centric occlusion. This placed his molars in a severe Class III relationship. His lower arch showed adequate space, with extruded lower incisors. His upper arch appeared to have adequate space. The maxillary dentition was narrow, compared with the mandibular arch posteriorly. In the pseudo Class III position, the patient showed a Class III facial pattern in the sagittal view and good symmetry in the frontal view.

A.Y.
BEGINNING
6.11 yrs

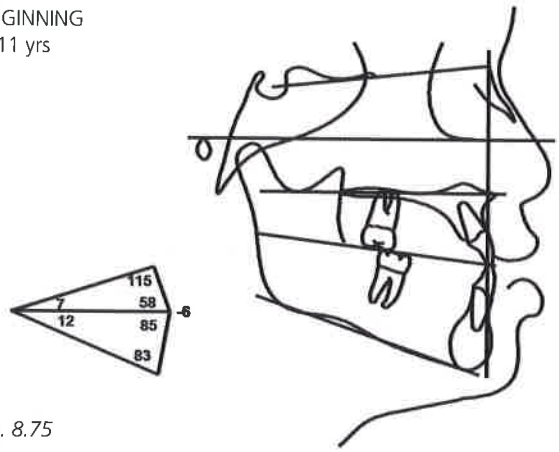


Fig. 8.75

SNA 82°
SNB 84°
ANB -2°
A-N ⊥ FH -2 mm
Po-N ⊥ FH 1 mm
WITS -6 mm
GoGn SN 21°
FM 19°
MM 19°
↑1 to APo 1 mm
↓1 to APo 1 mm
↑1 to Max Plane 115°
↓1 to Mand Plane 83°

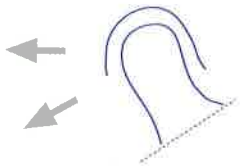


Fig. 8.75A The cephalometric records were taken at CR with the condyles centered in the fossae and a wax bite in place.

A.Y.
BEGINNING
6.11 yrs

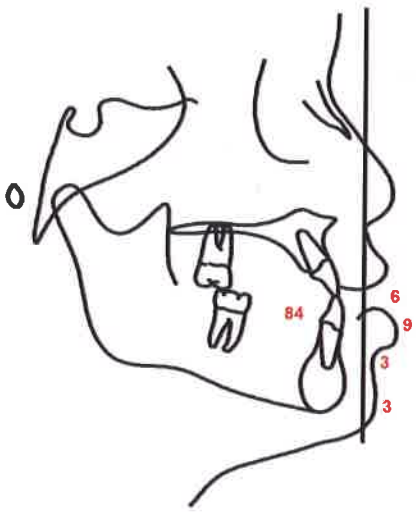


Fig. 8.76

↑ Incisor torque to occl. plane 57°
↑ Incisor tip to TVL -8 mm
↑ Lip thickness 15 mm
↑ Lip to TVL 6 mm

Max. anterior height 20 mm
↑ Lip length 18 mm
↑ Incisor exposure 2 mm
Inter-labial gap 6 mm

Occlusal plane to TVL 93°
↓ Incisor torque to occl. plane 84°
↓ Lip thickness 12 mm
↓ Lip to TVL 9 mm
Soft tissue 'B' point 3 mm
Soft tissue pogonion 3 mm

Cephalometric records (Fig. 8.75A) were taken at CR with the condyles centered in the fossae and a wax bite in place. The patient showed a Class III skeletal pattern, which was the result of a retrusive maxilla and a slightly protrusive mandible. The incisors showed considerable dental compensation, with an edge to edge position. The panoramic radiograph showed an early mixed dentition stage with adequate space in the lower arch and crowding of the permanent incisors in the upper anterior segment.

Fig. 8.77

Fig. 8.78

Fig. 8.79

Fig. 8.80

Fig. 8.81

Fig. 8.82

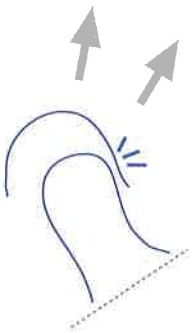


Fig. 8.80A The photographs were taken at CO, with the condyles not centered in the fossae and teeth in the pseudo Class III position.

Fig. 8.83

Fig. 8.84

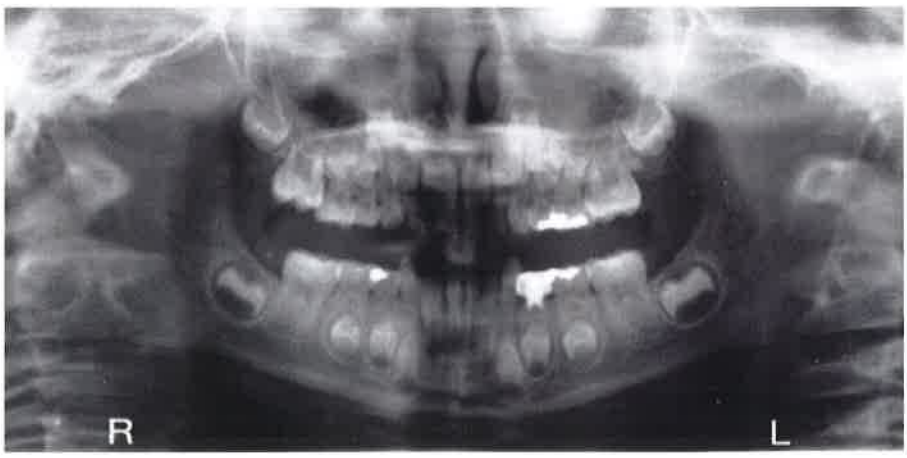


Fig. 8.85

The initial stage of treatment for this patient was to place a lower removable posterior bite plate to provide occlusal support and a more seated condyle position, with an edge to edge incisor bite. This was followed by rapid expansion of the maxilla. After expansion was completed, a palatal bar was cemented in place, with extension arms to the primary canines. Brackets were placed on the upper incisors to gently bring them together and to close space in the upper incisor area. As seen in the panoramic radiograph (Fig. 8.89), at this time there appeared to be adequate space for the permanent teeth in this low angle case.

Fig. 8.86

It was estimated that the patient was most likely going to be a surgical case, because of the skeletal Class III condition, the amount of incisor dental compensation and the edge to edge anterior bite. Therefore, no facemask therapy was suggested, as it would cause unacceptable further dental compensation of the anterior teeth.

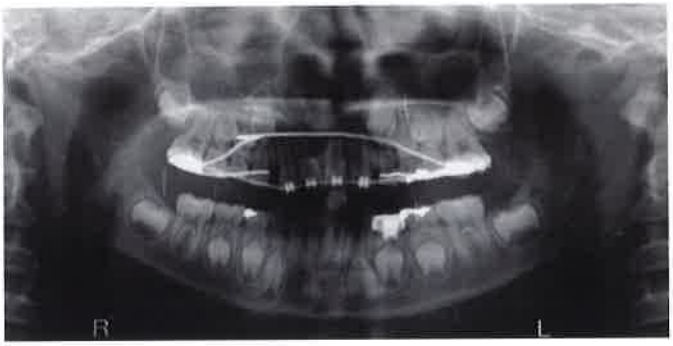


Fig. 8.89

An upper removable retainer was placed along with a vacuum formed lower retainer. The lower retainer had acrylic placed occlusally, which supported the posterior occlusion (Fig. 8.92 – 8.94).

Later (Fig. 8.95 – 8.97) a new acrylic lower splint was placed for continued support. Growth was monitored for a number of years until the eruption of the permanent dentition.

Fig. 8.92

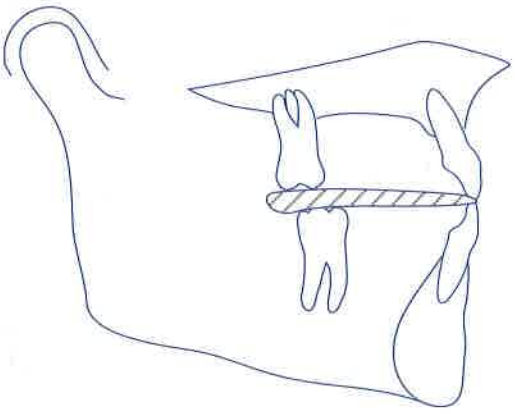


Fig. 8.95A A removable appliance, with posterior acrylic, to maintain a seated condyle position, and allow for better function.

Fig. 8.95

Fig. 8.87

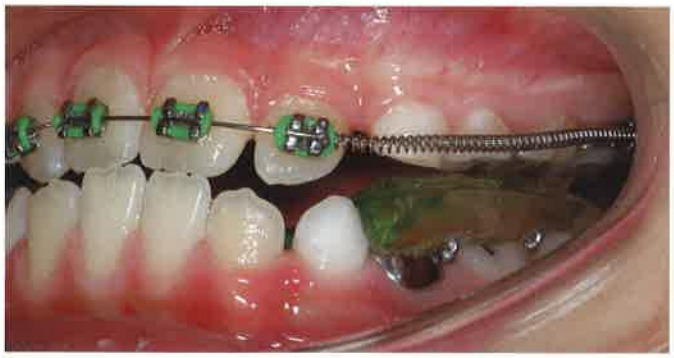


Fig. 8.88

Fig. 8.90

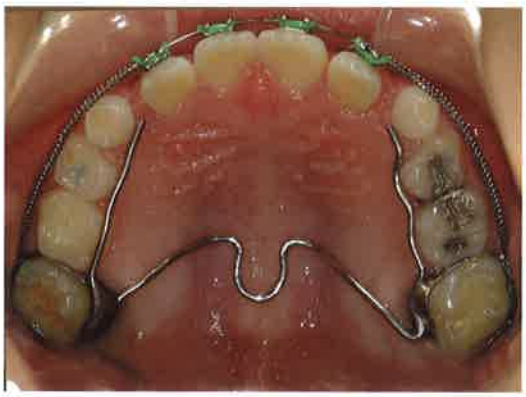


Fig. 8.91

Fig. 8.93

Fig. 8.94

Fig. 8.96

Fig. 8.97

The patient's occlusion is seen after eruption of most of the permanent teeth, and with the lower removable appliance removed. The molars were 3 to 4 mm Class III, and there was a substantial posterior open bite when the incisors were edge to edge (Figs. 8.98 – 8.100). There was mild spacing in the arches.

Fig. 8.98

The first palatal bar (Fig 08.91) had a loop for transverse adjustments, and extension arms to the primary canines, to maintain the width in the entire upper arch. Transverse adjustments are usually not needed, and the second palatal bar (Fig. 8.103) was designed to be straight wire across the palate, to hold the transverse dimension, as this was less cumbersome.

The 'Bollard' type of skeletal anchorage plates were placed at 13.5 years of age, to start Class III mechanics, aimed at producing skeletal improvement for this Class III case. These plates were developed by Dr. Hugo De Clerck (Fig. 8.101). The hooks on the lower plates can cause soreness to the inside of the lower lip immediately after placement, and protection with wax or acrylic is often helpful for a few days.

Fig. 8.101 An acrylic skull, showing the correct positioning of Bollard plates. Image kindly provided by Dr. Hugo De Clerck.

Two sequences of photos are shown, taken several months apart (Figs. 8.104 – 8.107) and (Figs. 8.107 – 8.109). There is little difference between the two sequences, as well as the progress records taken at 13.11 years of age on the next page. The exception is that the maxillary posterior teeth moved down slightly.

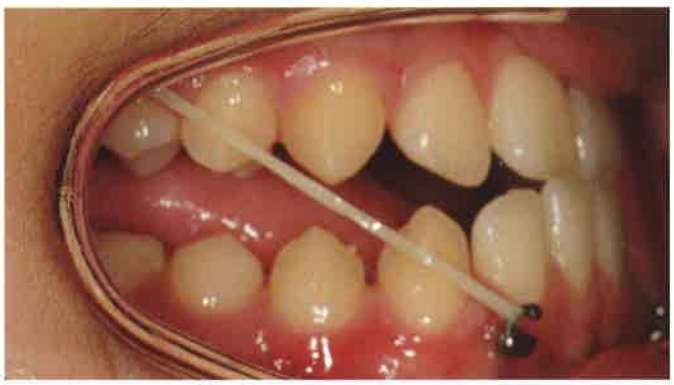


Fig. 8.104

There are three main reasons for the apparent slow progress at the start of Class III mechanics. First, there has been some rebound from the previously held position. Second, it can take some time for the patient to get into regular elastic wear, and to fully understand the importance of consistency. Third, there is inertia before changes occur, because we are seeking skeletal change, and osteoblasts and osteoclasts have to assemble. These factors take time, and patience is needed. The Class III elastics are ¼ inch - 4 to 6 ounce elastics, with a request for them to be worn full time, 24 hours per day.

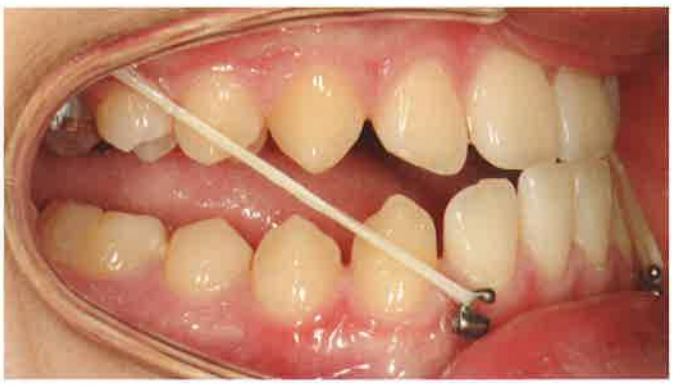


Fig. 8.107

Fig. 8.99

Fig. 8.100

Fig. 8.102 There was adequate space for the permanent teeth in this low angle case.

Fig. 8.103 This palatal bar was a straight wire across the palate, without a loop, as this was less cumbersome.

Fig. 8.105

Fig. 8.106

Fig. 8.108

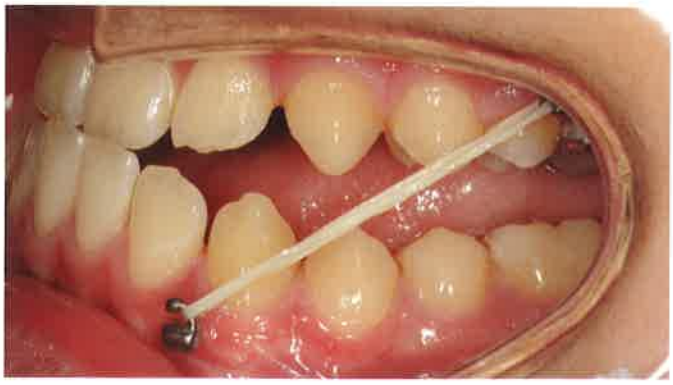


Fig. 8.109

Case report AY (progress records)

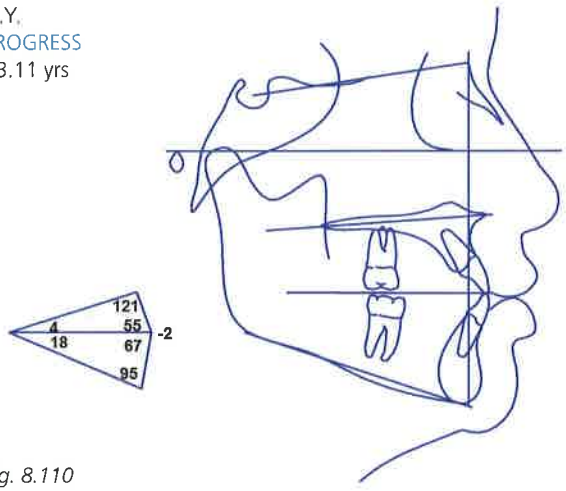


Fig. 8.110

SNA 82°
SNB 83°
ANB -1°
A-N ⊥ FH 1 mm
Po-N ⊥ FH 4 mm
WITS -2 mm
GoGn SN 24°
FM 18°
MM 22°
↑1 to APo 5 mm
↓1 to APo 4 mm
↑1 to Max Plane 121°
↓1 to Mand Plane 95°

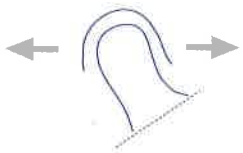


Fig. 8.110A The progress cephalometric records and photographs were taken at CR with the condyles centered in the fossae.

Due to the factors previously discussed, the tracing of the progress cephalometric radiograph (Fig. 8.110) at 13.11 years, shows minimal change compared with the starting measurements, other than anticipated growth changes, such as a more prominent mandible. The dentition shows a similar position to the previous two photographic sequences.

Fig. 8.114

Fig. 8.117. This progress panoramic radiograph shows the positioning of the Bollard plates on the zygomatic arches and between the lower lateral incisors and lower canines.

Fig. 8.111

Fig. 8.112

Fig. 8.113

Fig. 8.115

Fig. 8.116

Fig. 8.118

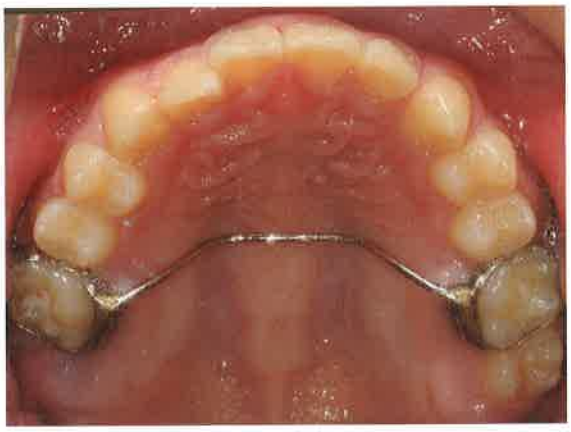


Fig. 8.119

Case report AY (second phase)

The palatal bar was removed before setting up the case, using indirect bonding. The upper right second molar was not fully erupted, so bonding of a tube was not possible for this tooth. Apart from this, brackets and tubes were placed on all erupted teeth, which is essential in this type of case. In particular, the lower second molars were included in anticipation of the use of Class III elastics to the dentition when the case reaches rectangular steel wires. (Fig. 8.124). If lower second molars are not included, Class III elastics will move the lower first molars slightly distally, and cause extrusion of the lower second molars.

The lower incisor brackets (Fig. 8.123) were inverted to change the normal -6° of torque (labial root torque) to +6° of torque (lingual root torque). This change prevents excessive retroclination of the lower incisors due to Class III elastics being worn to the dentition for long periods (chapter 5). The initial wires were the normal .016 HANT type, and elastics continued to be worn to the skeletal plates. The skeletal forces were important, as well as the anticipated dental forces later.

Upper and lower .019 / .025 steel working wires were placed. Elastics continued to be used on the plates for skeletal change, and lighter 5/16 inch, 4 ounce Class III elastics were used to the archwire hooks, for dental change (Figs. 8.126 – 8.128). Passive wire tiebacks were in place.

The hook positions of the lower wire (Fig. 8.128) are close to the lateral incisor brackets, and not in the normal position, midway between the canine brackets and the lateral incisor brackets. This is in anticipation of lower anterior space closure. Later (Fig. 8.134) a more centered hook position can be seen, as the space closes.

A good change in the incisor relationship was seen, and elastic chain was used for final space closure in the lower arch (Figs. 8.129 – 8.131). Class III elastics continued to be worn to the plates, and lighter Class III elastics for the dentition. The hooks on the lower rectangular steel wire were clipped and smoothed, to avoid snagging the hooks of the plates, and to help with patient identification about 'which elastics go where'.

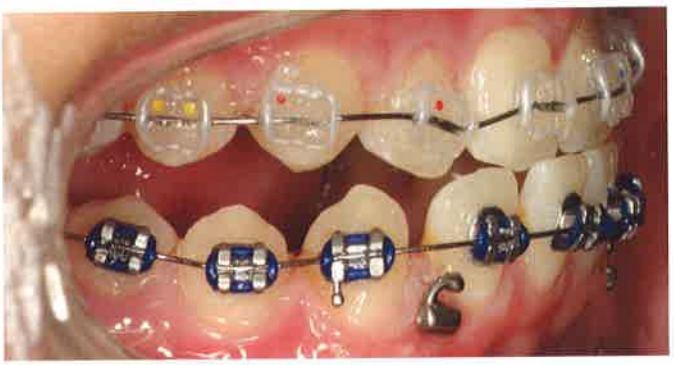


Fig. 8.120

Fig. 8.123 The lower incisor brackets were inverted to change the -6° torque to +6° of torque.

Fig. 8.126

Fig. 8.129

Fig. 8.121

Fig. 8.122

Fig. 8.124

Fig. 8.125

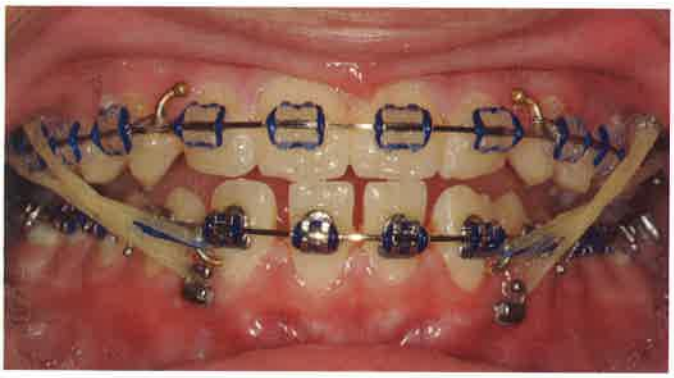


Fig. 8.127

Fig. 8.128

Fig. 8.130

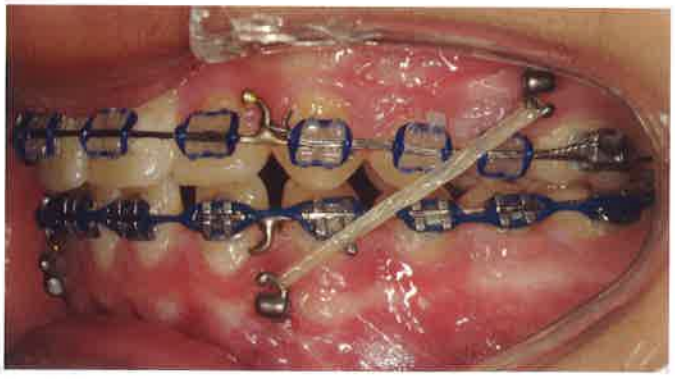


Fig. 8.131

Later in treatment, the dentition showed a good improvement in response to the combination of skeletal and dental mechanics, and the posterior segments became slightly Class II (Figs. 8.132 – 8.134). At this stage there was some space to close in the lower arch, which would create more overjet and allow for some reduction in upper incisor torque. The systemized approach to orthodontics has come into play in this challenging case, and normal mechanics can now be seen.

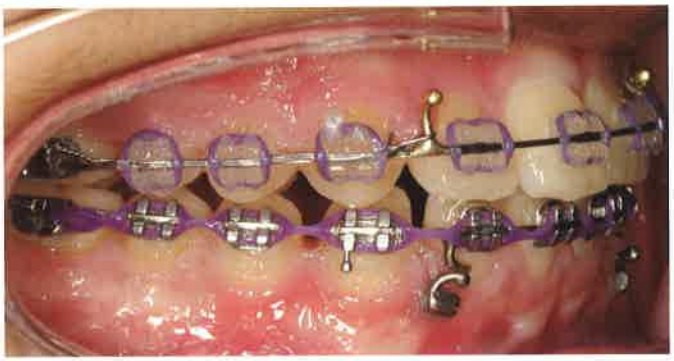


Fig. 8.132

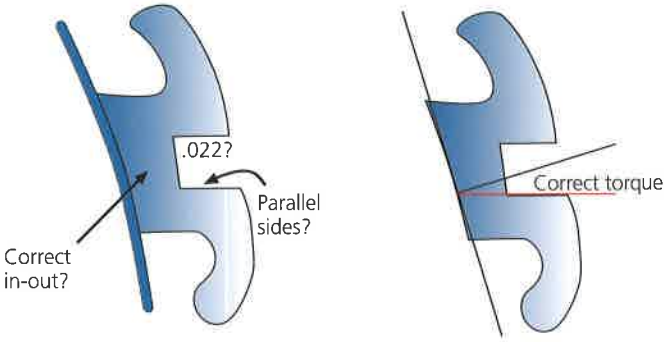


Fig. 8.135 There are benefits from an accurate bracket system, such as the Avex™ range, used by the authors.

Fig. 8.135A Correct positioning can be achieved in most cases, with indirect bonding.

The benefits can be seen from using the accurate Avex™ bracket system, and correct positioning with indirect bonding (Figs. 8.135 & 8.135A). The orthodontist can concentrate on the Class III aspects of treatment, without having concerns about tooth alignment, and the case can move into routine finishing (chapter 12) using the normal methods. The malocclusion was slightly overcorrected, which was good, and there was a need for light Class II elastics on the left side for a short period (Fig. 8.140). Torque could be reduced in the upper incisor area, accompanied by some enamel reduction of the large upper incisors.

Fig. 8.138

As part of normal finishing, a lower .016 HANT wire was placed to hold tooth positions and allow lower arch transverse settling, if needed. For the upper incisors, a .014 steel wire was placed, which maintained incisor alignment and allowed vertical settling from canines to second molars.

Fig. 8.141

Fig. 8.133

Fig. 8.134

Fig. 8.136

Fig. 8.137

Fig. 8.139

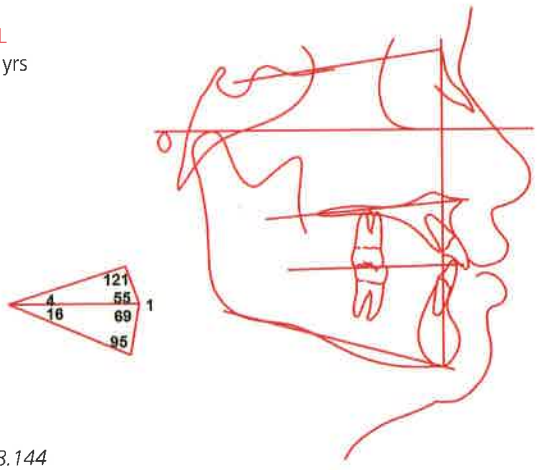
Fig. 8.140

Fig. 8.142

Fig. 8.143

The final cephalometric tracings show a favorable increase in theWits number from -6 mm to +1 mm. The lower incisors are in a satisfactory position, and upper incisors remain dentally compensated. The soft tissue profile is good. Progress and final tracing superimpositions (overleaf) show that the maxilla has advanced more than the mandible has grown. There has not been significant opening of the mandibular plane, and the occlusion is Class I. The plates will remain until stability is assured. Then, the external attachments only will be removed.

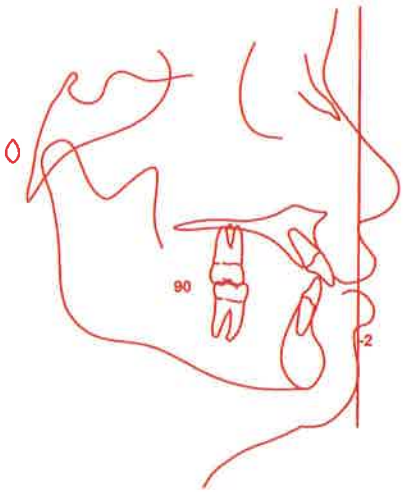
A.Y.
FINAL
14.8 yrs



SNA 84°
SNB 83°
ANB 1°
A-N ⊥ FH 3 mm
Po-N ⊥ FH 6 mm
WITS 1 mm
GoGn SN 19°
FM 14°
MM 20°
↑1 to APo 5 mm
↓1 to APo 0 mm
↑1 to Max Plane 121°
↓1 to Mand Plane 95°

Fig. 8.144

A.Y.
FINAL
14.8 yrs



↑ Incisor torque to occl. plane 53°
↑ Incisor tip to TVL -9 mm
↑ Lip thickness 16 mm
↑ Lip to TVL 6 mm

Max. anterior height 22 mm
↑ Lip length 21 mm
↑ Incisor exposure 1 mm
Inter-labial gap 3 mm

Occlusal plane to TVL 90°
↓ Incisor torque to occl. plane 67°
↓ Lip thickness 14 mm
↓ Lip to TVL 6 mm
Soft tissue 'B' point -2 mm
Soft tissue pogonion 0 mm

Fig. 8.145

Summary

The Bollard plates provide an excellent alternative to manage Class III cases that show a possible future need for surgery. As pointed out by Dr. De Clerck, successful use of the plates can provide approximately 4 to 5 additional millimeters of advancement of A point. This has not been proven to be attainable with conventional face mask therapy.

Fig. 8.146

Fig. 8.147

Fig. 8.148

ig. 8.149

Fig. 8.150

Fig. 8.151

Fig. 8.152

Fig. 8.153

Fig. 8.154

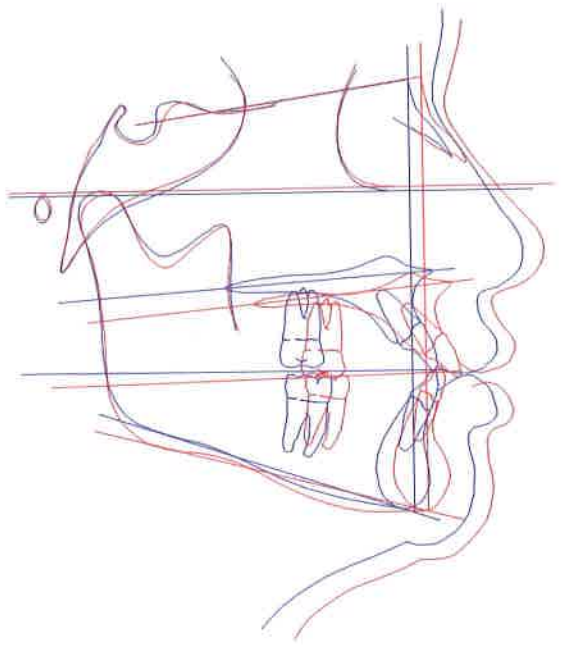


Fig. 8.155 Superimposition on SN at sella shows considerable forward growth of the mandible during the second phase of treatment. However, this was more than balanced by favorable downward and forward growth of the maxilla, which allowed a Class I dental result to be achieved, without excessive dental compensation.

Notes. The patient presented at age 6 years 11 months, with mandibular protrusion at centric occlusion (Fig. 8.156). Early correction of this type of problem is essential (Fig. 8.157) because the condyles are forward of an ideal central position in the fossa, and this can encourage ongoing growth, in the same way as a functional appliance. Without treatment there is potential for the Class III pattern to worsen. Therefore, a removable acrylic appliance, with posterior bite support was worn for several years, to allow proper condyle seating.

These appliances are normally well accepted by patients, as they allow improved masticatory function. With a pseudo Class III bite, only a 'chopping' movement is possible.

The second stage of treatment was delayed until almost all permanent teeth had erupted. This allowed assessment of the Class III growth, and enabled the case to go into full fixed appliances soon after the plates were placed for optimal mechanics. As with all Class III treatments, the patient and family were informed of the possibility of latent growth occurring.

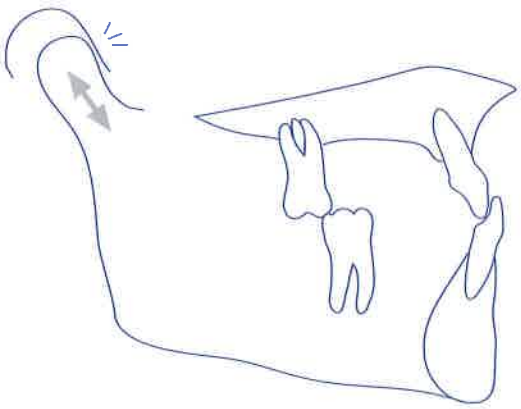


Fig. 8.156 At the start of treatment, the condyles were forward of an ideal central position in the fossae, which can encourage ongoing growth.

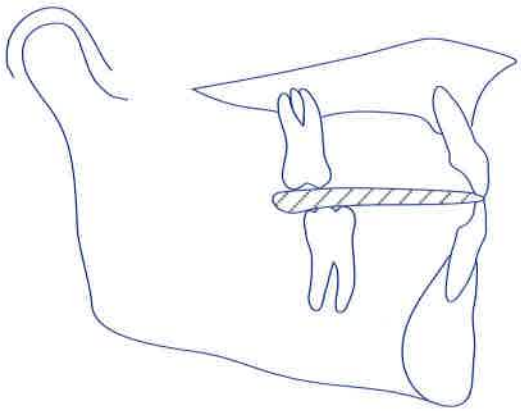


Fig. 8.157 A removable acrylic appliance, with posterior bite support was worn for several years, to allow proper condyle seating

CHAPTER 9

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Non-extraction treatment

Introduction

The primary focus in the treatment mechanics portion of this book is on intra-arch mechanics for patients with a Class I (or nearly Class I) dental relationship. In these cases, the lower arch is a key focus in diagnosis and treatment planning. A non-extraction approach is normally indicated if the lower arch can be properly treated without extractions, and transverse and vertical factors are manageable in the upper arch.

If there is spacing in the arches of Class I cases, non-extraction treatment is usually appropriate, unless there is severe protrusion, and there is little controversy in orthodontics concerning uncrowded cases.

However, in cases with crowding, orthodontists have different viewpoints about the methods of creating space for tooth alignment, and this in turn leads to a range of opinions concerning extraction versus non-extraction treatment.

The methods of creating space

The methods of creating space for tooth alignment are shown below, and are as follows:

1. The advancement of lower incisors (Fig. 9.01).
2. Interproximal enamel reduction – IPR (Fig. 9.02).
3. Tooth movements among canines, premolars and molars (Fig. 9.03).

Fig. 9.01 The advancement of lower incisors.

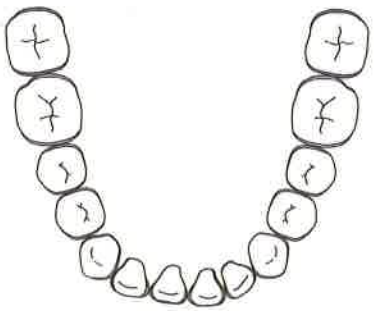


Fig. 9.02 Interproximal enamel reduction (IPR).

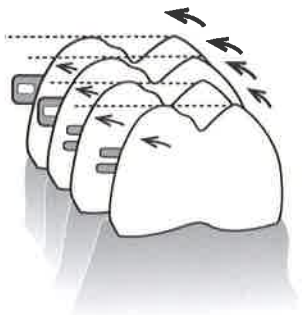


Fig. 9.03 Tooth movements among canines, premolars and molars.

The advancement of lower incisors

The lower incisor area is considered to be one of the most unstable areas in the dentition. It is subjected to pressure from the tongue and the mentalis muscle, along with the forces of occlusion. Additionally, if mesial movements occur among the lower canines and posterior teeth, force is applied to the lower incisors.

It has been suggested that the most stable position for the lower incisors is their original 'naturally established' position. However, if tongue posture or activity is modified for any reason, this may allow a natural change in incisor position. Also, in a case where lower incisors are retroclined, in combination with a deep complete overbite, correction of the overbite often allows a natural change in lower incisor position.

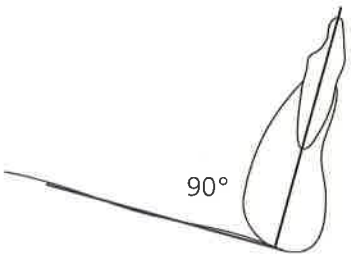


Fig. 9.04 Tweed recommended 90° to the mandibular plane as the ideal lower incisor position.

Tweed suggested that the most stable position for the lower incisors was 90° to the mandibular plane (Fig. 9.04). This allowed for forces to be directed along the long axis of these teeth, which allowed them to better withstand the forces of occlusion [1].

However, the Tweed approach to lower incisor position does not take into account the beneficial factor of dental compensation (B3 page 176). This can be used to correct the incisor relationship in many Class II and Class III malocclusions, often on a non-extraction basis (Figs. 9.05 & 9.06). Dental compensation can even make a non-surgical approach possible in some severe cases, which would need surgery if lower incisors were required to be at 90°.

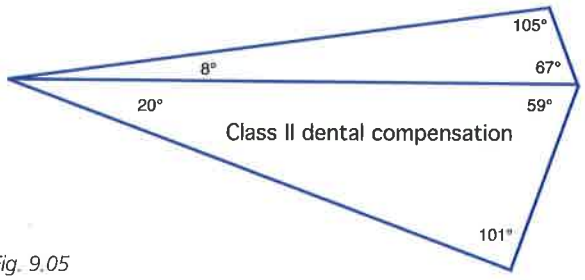


Fig. 9.05

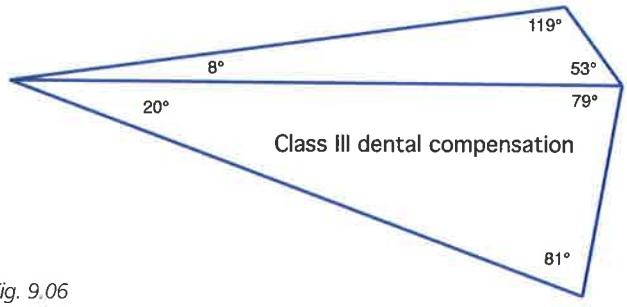


Fig. 9.06

Figs. 9.05 and 9.06 Dental compensation can be used to correct the incisor relationship in many Class II and Class III malocclusions, often on a non-extraction basis.

Changing incisor position can also lead to better esthetics in many cases. However, it must be admitted that too much dental compensation can lead to incisor relapse, as well as gingival recession and alveolar bone loss.

Considering the Tweed principle for lower incisor position, as well as the Michigan normals [1,2] the authors regard the ideal position for lower incisor position to be from 90 to 95° to the mandibular plane. In most cases dental compensation should be limited to 5°, but up to 10° can be considered in some situations.

With dental compensation, the size of the symphysis is a factor. Examination of dried skulls shows that the anatomy of the symphysis can be expected to limit bodily movement of lower incisors labio-lingually. Any changes are likely to be labial or lingual tipping (torque changes) rather than bodily movement. However, there is individual variation. Patients with a larger symphysis, often seen in cases with a short distance between the occlusal plane and the mandibular plane, may have more cancellous bone available for dental compensation. Patients with a thin symphysis, often seen with a large angle between the occlusal and mandibular plane (showing a great deal of lower vertical alveolar development) may have less cancellous bone. If dental compensation is considered, patients should be informed of the potential for post-orthodontic change and hence the importance of retention.

Geometrically, 2.5° of mesial tipping creates about 1 mm of movement at the lower incisor edge per side. Thus, if incisors are tipped forwards 5°, this provides 2 mm of space per side, which is a total of 4 mm of space (Fig. 9.07). When lower incisors require retraction, the same formula for space required applies. These figures are useful in treatment planning, remembering that they are approximations, and vary slightly with the size of the incisors and the starting torque position.

Fig. 9.07 Incisor torque can be changed to create or reduce space. If lower incisors are tipped forwards 5° during treatment, this provides approximately 2 mm of space per side, to give a total of 4 mm of space.

Interproximal enamel reduction (IPR)

Interproximal enamel reduction plays an important role in orthodontics. If correctly performed, it can be regarded as a safe procedure, and it is helpful in three main areas:

- It allows a higher number of cases to be treated without extracting teeth.
- It is essential in many cases for the correction of tooth size discrepancies.
- It allows reshaping of triangular teeth to reduce the incidence of dark triangles.

The safety of careful IPR in the lower anterior segment was investigated by Zachrisson and coworkers in a study of 61 consecutive patients over a 10 year period following interproximal enamel reduction of all six mandibular anterior teeth [3]. The study showed that when using the described protocol, IPR did not result in iatrogenic damage. The incidence of dental caries, gingival problems or alveolar bone loss did not increase. In addition, 59 of the 61 patients reported no increased sensitivity to temperature variations.

In a study of posterior teeth, 43 subjects from 19 to 71 years of age were evaluated. All had received careful IPR of anterior and posterior teeth 4 to 6 years previously [4]. The incidence of interproximal caries was compared between reproximated and unground contralateral surfaces in the same patient. Interdental enamel reduction with this protocol did not result in an increased caries risk in posterior teeth. They found no evidence that proper mesiodistal enamel reduction within recognized limits (approximately 1/4 -1/2 mm per surface) will cause harm to the teeth or supporting structures. None of the 43 patients reported increased sensitivity to temperature variations.

Other studies have found similar results, and concluded that there is not an increased risk of caries after IPR [5&6]. Additionally, it has been reported that the application of topical fluoride on the adjusted enamel surfaces, immediately after enamel reduction, in patients exposed to fluoridated water and fluoride-containing toothpaste, may not provide any additional benefit [5]. Procedures for IPR are discussed later in this chapter (pages 148 – 152).

Canine, premolar, and molar movements

Torque changes among canines

As discussed in chapter seven, lower canines in deep bite cases tend to be inclined lingually due to the contact with the palatal surfaces of the upper canines. As the bite opens in Class II/2 treatment, the lower canines can be positioned in a more appropriate torque position, and they can be expected to remain stable if the bite does not close after treatment [7]. A modest amount of inter-canine space can be gained in this way (Fig. 9.08). After rapid maxillary expansion in the upper arch, it has been reported that lower intercanine width will increase by an average of 1.1 mm and intermolar width by an average of 2.9 mm [8].

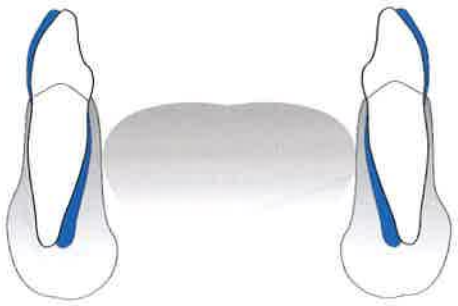


Fig. 9.08 As the bite opens in deep bite cases, the lower canines can be positioned in a more appropriate torque position, and a modest amount of space can be gained. It has been reported that lower intercanine width will increase by an average of 1.1 mm.

Torque changes among premolars and molars

In cases with a steep curve of Wilson at the start of treatment, torque changes often occur among lower premolars and molars during levelling and aligning (Fig. 9.09). This can provide a small amount of space to assist in solving crowding. It is important to recognize cases with a steep curve of Wilson, because there will be a need for upper arch dental expansion, or even rapid maxillary expansion, to compensate laterally for the changes which inevitably occur in the lower arch. Without upper expansion, a difficult crossbite situation can develop later in treatment, particularly with the upper second molars.

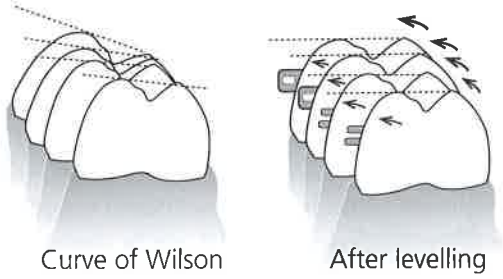


Fig. 9.09 During the early stages of treatment, correction of a steep curve of Wilson can provide a small amount of lower arch space. There is normally a need for upper arch dental expansion, or even rapid maxillary expansion, to compensate laterally for the changes which inevitably occur in the lower arch.

Canine, premolar, and molar expansion after upper arch widening

If treatment includes palatal expansion in the upper arch, the lower buccal segments tend to move buccally also (Fig. 9.10). As noted above, this can create an increase of 1 mm in inter-canine width, and 3 mm in the inter-molar width [8]. The change in inter-molar width provides about 0.5 mm of space of arch length per side. Together, these processes can increase the arch length by about 2 mm.

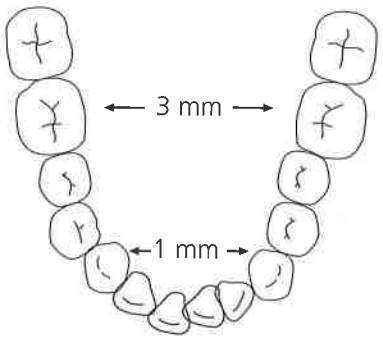


Fig. 9.10 The lower molars, premolars, and canines tend to move buccally after upper expansion.

Distal movement of molars

In the past, lip bumpers and other methods were used to attempt distal movement of lower molars. However, in cases with lower second and third molars present, this is normally met with limited success. Any changes tended to be tipping, and the molar crowns were liable to move mesially again, later in treatment. Also, unless posterior teeth were extracted, distal movement was not increasing the available space for the lower dentition, but could be seen as merely transferring the crowding (B2 page 13).

In most cases, distal movement of molars is not a reliable source of space, although early removal of third molars can improve the chances of success, particularly in Class III cases where minor distal movement is required. The authors have previously discussed extraction of lower second molars as a treatment option in a small number of difficult Class III malocclusions, and they have reported on a case (B2 page 332).

(Expansion and growth of alveolar bone)

Claims have been made that arch length can be increased to greater amounts through expansion and growth of alveolar bone. Evidence in the literature to date, as well as the clinical experience of the authors, does not support such claims. Relapse and periodontal complications are seen if arches are over-expanded.

Treatment mechanics for crowded and blocked out teeth

The following comments on mechanics apply equally to non-extraction and extraction cases, but are more relevant in extraction cases, as discussed in chapters 10 and 11.

The authors have found that it is inefficient to place brackets on crowded teeth at the start of treatment, when space is not available. The same is true for 'blocked out' teeth. (In this context the term 'blocked out' describes a tooth which has considerable vertical or horizontal misplacement from the line of the arch.)

As a rule, at the start of treatment it is better to delay placing brackets on crowded or blocked out teeth until space has been made for them. Such teeth can be aligned more quickly when space is available. If they are bracketed too soon, flexible wires are needed for a longer period of time, and this can delay stabilization of the arch form. It also brings a risk of slower tooth alignment, arch form distortion, and 'round tripping' if blocked out or crowded teeth are tied in with light wires before space is available. (In this context the term 'round tripping' describes a situation when the roots of teeth move through the same bone twice, which is obviously inefficient.)

Wire sequencing in non-extraction cases

The following arch wire sequence is most commonly used for non-extraction cases:

- .016 heat activated nickel titanium (HANT) wires. Occasionally lighter HANT wires can be used. These wires are normally left in for one or two visits.
- .019 / .025 HANT wires. These typically follow the .016 HANT wires, but .016 / .022 HANT wires may be needed in a few cases at this stage. The rectangular HANT wires can be left in place for two to three visits and retied as needed.
- .020 stainless steel round wires. These wires are sometimes needed to help arch levelling, because HANT wires are excellent for aligning, but are less effective for overbite control.
- .019 / .025 stainless steel wires. These are the main working wires, and are used to complete the arch levelling, torque control, and final arch shaping. They also support various types of intermaxillary elastics.
- Final settling wires. Various combinations of settling wires are used ahead of appliance removal, and are discussed in chapter 12 on settling.

Decision making in non-extraction cases – three questions to ask

When making the extraction decision, it is helpful to ask three questions:

- Which methods of resolving crowding (Figs. 9.01, 9.02 & 9.03) are appropriate in this case?
- How much space can be safely gained from these procedures?
- Will the space gained be enough to correct the arch length discrepancy? (If so, then non-extraction treatment is the best choice. If not, then teeth will need to be extracted to provide proper treatment.)

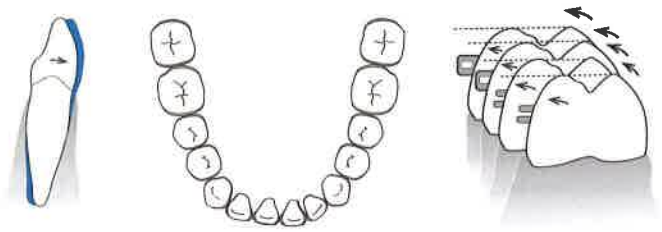
The 'progress review' of cases during treatment

In all treatments it is helpful to carry out a progress review, because it leads to earlier completion in many cases. This involves an appointment which is longer than normal, and is informally known as 'clean up time'. It reduces tedious work during the later stages of treatment.

The timing of the progress review varies from case to case. In non-extraction treatments it is often convenient after .019 / .025 HANT wires have been in place for one or two visits and before placement of the .019 / .025 steel wires (case AO page 160). This generally corresponds with the end of the levelling and aligning process, as overbite control is going on, and before space closure is started. On the other hand, the progress review can be done later in treatment if key procedures are being carried out. For example, in the extraction case report RO (page 207) the progress review was delayed until the majority of space closure was complete and ahead of the finishing and detailing.

A careful progress review greatly reduces the treatment time in some cases. It allows any previous inadequacies to be corrected, so that finishing and detailing is quicker and easier. It can include the following steps:

Checking bracket positions
When necessary, brackets are repositioned to an ideal position and a lighter wire such as a .019 / .025 HANT is used to realign the teeth. The case can then move up to (or return to) .019 / .025 steel working wires. Bracket positions can be checked visually, but if there is clearly a need for some repositioning, it is normally better to use progress study models and intra-oral photographs with the teeth apart. When appropriate, a panoramic radiograph can be taken to evaluate root positions.



Figs. 9.01, 9.02 and 9.03 repeated from page 142. The accepted methods of creating space are advancement of lower incisors, interproximal enamel reduction, and tooth uprighting among molars, premolars, and canines.

Idealization of arch form
As described in chapter seven, and in a previous text (B3 page 79) one of three standard arch forms is used in the early stages of treatment. When the case is ready for .019 / .025 steel wires, a wax template is set over the lower arch to create indentations of the lower brackets. The rectangular steel wire is shaped to these bracket indentations, compared and adjusted to the original arch form, and then the wire is copied on to paper, cut out, and placed on an index card. This template is used for arch form and arch wire coordination during the rest of treatment, as described in chapter seven.

Review of cephalometric aspects of the case
In cases where there has been considerable tooth movement and/or growth, it is helpful to take a progress cephalometric radiograph to review the skeletal, dental and facial aspects of the case.

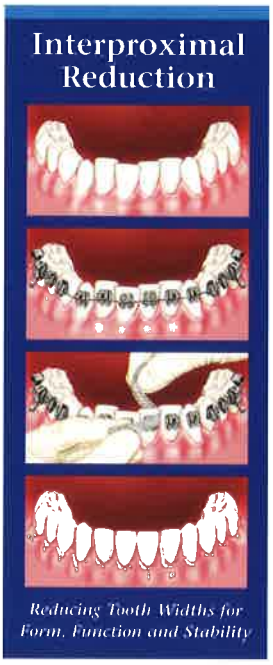
Treatment procedures during enamel reduction (IPR)

The following issues are important in enamel reduction:

- Patient communication
- The timing of lower IPR – after incisor alignment
- The timing of lower IPR – before incisor alignment
- The timing of upper IPR
- The amount of enamel removal – lower posteriors
- The amount of enamel removal – lower anteriors
- Accuracy in enamel removal
- The need for separation
- Methods of enamel reduction
- Restoring crown anatomy
- Polishing enamel surfaces after IPR

Patient communication

If enamel reduction is part of the treatment plan, it is helpful to provide reassurance and motivation for the patient at the case presentation. There are often concerns that IPR will have 'consequences' such as an increased risk of tooth decay, periodontal disease, and temperature sensitivity, and information should be provided about this (Figs. 9.11 A & B). Literature is available from professional associations [9] and abstracts from scientific papers can also be helpful [3,4,6,10]. If IPR is needed, patients may require several visits to manage anterior separation. It can be explained that there may be some inconvenience and discomfort, but this is necessary to avoid extractions or a compromised result.



Figs. 9.11 A & B

Patients will ask about enamel reduction, and information should be provided about this. Literature is available from professional associations, and on the right is the leaflet available from the AAO. Abstracts from key scientific papers can also be helpful, such as the two papers by Zachrisson and coworkers [3,4].

The timing of lower IPR (after incisor alignment)

It is easier to perform enamel reduction if the teeth are well aligned. Accordingly, it may seem logical to procline crowded lower incisors into alignment, to simplify the process of IPR, and then retrocline them after enamel reduction (Fig. 9.12). In the study by Zachrisson and coworkers [3] the patients' lower incisors were aligned for one or two visits before IPR. However, this is often not the best approach for four reasons. First, the incisors are slow to align, because there is no space available in the line of the arch. Second, there is round tripping of the lower incisors (page 109). Third, the posterior teeth tend to drift mesially after IPR and during incisor retraction, which will reduce the amount of A/P correction of the incisors, and fourth, there can be distortion of the arch form.

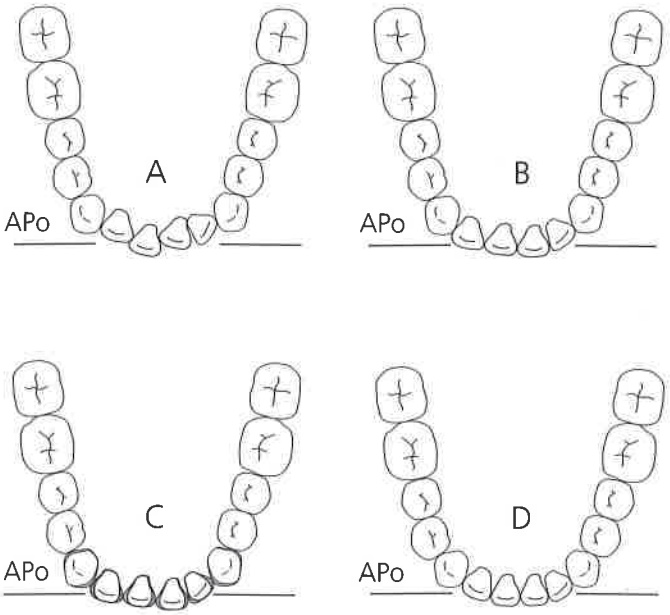


Fig. 9.12 It is easier to perform enamel reduction if the teeth are well aligned. However, the incisors may be slow to align (A to B) because there is no space available in the line of the arch. Also, the posterior teeth tend to drift mesially after IPR and during incisor retraction (C to D) which will reduce the amount of A/P correction of the incisors. In this illustration, the enamel reduction shown is more than would normally be appropriate in the mouth.

The timing of lower IPR (before incisor alignment)
If enamel reduction is planned to resolve crowding in the lower arch, it is usually better if the IPR is done at the start of the treatment. This makes immediate space available, and if needed, light open coil springs can be used in the areas of crowded teeth, on heavier stainless steel round wires. Arch form stabilization is easier when using these wires.

The process of IPR is a little more difficult with irregular incisors, than if they are well aligned. However, there are advantages to early IPR of crowded and/or overlapping teeth, before bracketing them. After space has been created, crowded and blocked out teeth can be bracketed and moved with greater efficiency (Fig. 9.13). The incisors align rapidly, with minimal proclination, and there is no round tripping. There is little or no distortion of the arch form.

The timing of upper arch IPR
In the upper arch, enamel reduction is usually delayed until the end of the treatment, unless it is obviously needed. Tooth size discrepancies commonly occur in the upper anterior segment. It is easier to visualize these at the end of treatment, after the buccal segments have been corrected, and the lower incisors have been set in the correct position. So, in the upper anterior segment, a small advancement of incisors (to create a slightly increased overjet, as in case NH page 228) is a safer option than early IPR. It is seldom necessary to adjust tooth substance among the upper posterior teeth, unless there are abnormally shaped teeth or oversize restorations at the start of treatment.

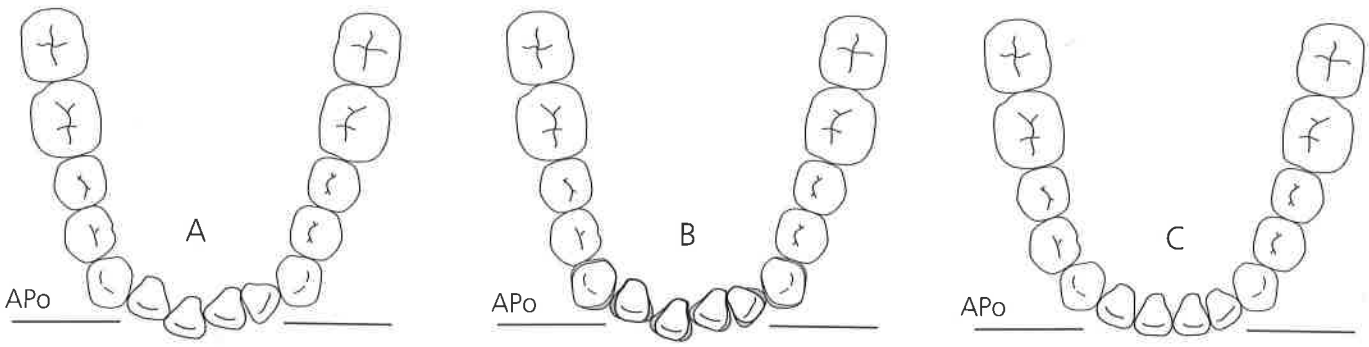


Fig. 9.13 The process of IPR is a little more difficult with irregular incisors (A to B). However, after space has been created in this way, the incisors align rapidly (B to C) with minimal proclination, and there is no round tripping. For illustration purposes the amount of enamel reduction shown is more than would normally be appropriate in the mouth.

The amount of enamel which can be removed from the lower posterior teeth
Enamel thickness has been studied extensively. A study of 98 Caucasian patients, aged between 20 and 35 years, used bitewing radiographs to assess the thickness of mesial and distal enamel on mandibular first and second molars and premolars [11]. It was found that distal enamel was thicker than mesial enamel, with no significant differences between males and females. Overall, a total of approximately 10 mm of enamel was found in each lower arch quadrant. The study noted that, assuming 50% enamel reduction, the premolars and molars should provide 9.8 mm of additional space for alignment of mandibular teeth. Furthermore, 95% of the patients in the study could gain 7.3 mm of space in the mandibular arch from enamel reduction among molars and premolars (Fig. 9.14).

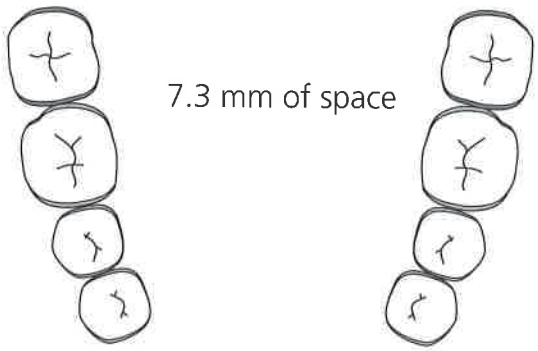


Fig. 9.14 It has been reported that most patients could gain 7.3 mm of space in the mandibular arch from enamel reduction among molars and premolars.

The amount of enamel which can be removed from the lower anterior teeth

Predictably, enamel on lower incisors has been reported to be thinnest at the cement-enamel junction, becoming progressively thicker towards the incisal edges, with no correlation between enamel thickness and crown length [12]. In the same study, enamel thickness curves were produced from measuring the mesial and distal surfaces of 27 lower incisors (Fig. 9.15B). The mean thickness on the mesio-incisal area was found to be 0.62 mm, with a range of 0.42mm to 0.82mm. The mean thickness on the disto-incisal area was reported to be 0.64 mm with a range of 0.44mm to 0.84mm (Figs. 9.15 A & B). The average width of a lower incisor is 5.5 mm [19] and if 0.25 mm is removed mesially and distally, this represents about 10% of the tooth dimension.

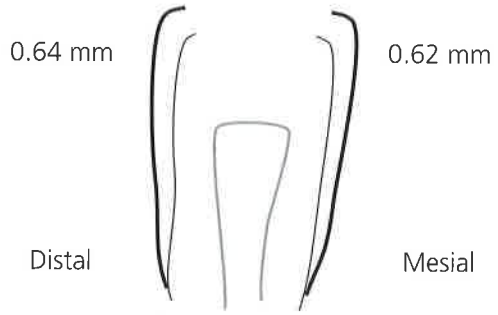


Fig. 9.15A It has been reported that the mean thickness of lower incisor enamel on the mesio-incisal area is 0.62 mm, and on the disto-incisal area 0.64 mm. However, there is wide individual variation. (Drawn approximately to scale).

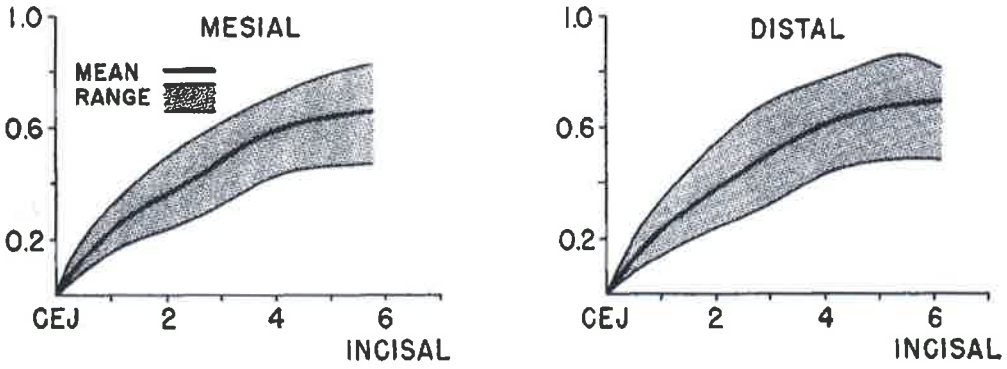


Fig. 9.15B The above diagram, taken from Gillings and Buonocore [12], shows the average true enamel thickness distribution curves, in millimeters, for the mesial and distal surfaces of lower incisors, based on the measurement of 27 teeth. The mean and range were plotted in millimeters of enamel thickness versus distance from the cement-enamel junction in millimeters.

It is difficult to predict enamel thickness, and the studies report considerable individual variation. Among lower incisors, significantly greater thickness was found on lateral incisors, distal surfaces, wider teeth and the teeth of African-American subjects [13]. No difference was found between males and females. A key finding was that lower incisor enamel thickness varied greatly among patients (between 0.44 mm and 1.28 mm) and this was not fully explained by the above factors alone. The authors recommended that if substantial enamel reduction is planned as part of treatment, clinicians should use calibrated radiographs to measure the thickness of the patient's enamel surfaces, because of the extensive variations [13].

There is extensive research on enamel thickness, but it is interesting that there are no randomized clinical trials to define the amount of enamel reduction that is 'safe'. In the orthodontic literature there have been no studies to document the ideal amount of enamel that can be safely removed, but there are essentially no studies that report iatrogenic outcomes after IPR has been carried out. It would seem that common sense should prevail. If leaving some enamel on the teeth is considered essential, then the removal of 0.25 mm interstitially would seem perfectly safe. While the authors have removed more than that amount at times, it is up to the clinician's discretion.

Accuracy in enamel removal

Research has shown that it is difficult to be precise when removing interstitial enamel. In laboratory tests, using 180 extracted premolars, there were large variations between the intended and the actual amounts of enamel removed, and between the various techniques used. In most cases the actual enamel reduction was less than the intended amount, and the technique used did not appear to be significant [14]. A sliding caliper can be used to measure the width of an incisor before and during enamel reduction, and thickness gauges are available from the companies. These are useful methods of checking the amount of enamel which is being removed.

The need for separation

It is recommended that teeth should be separated before attempting IPR. Without separation it is difficult to accurately remove the planned amount of enamel, and there is a risk of tooth damage.

Removable separators are normally left in place for four or five days (Fig. 9.16). The doughnut shaped type seem to be more comfortable than the type stamped out from a sheet. Removable separators are time consuming and are not popular with patients, as they tend to be uncomfortable and it can be difficult to keep them in place.

The Elliott Anterior Straight Separator is a good alternative to removable separation, and is particularly useful when teeth are not overlapped (Figs. 9.17 & 18). Topical anesthetics can be helpful and the effect of pressure anesthesia also reduces discomfort, so it is no more of an issue than the soreness with separators. This device has been shown in the published literature [3] and is recommended by the authors.

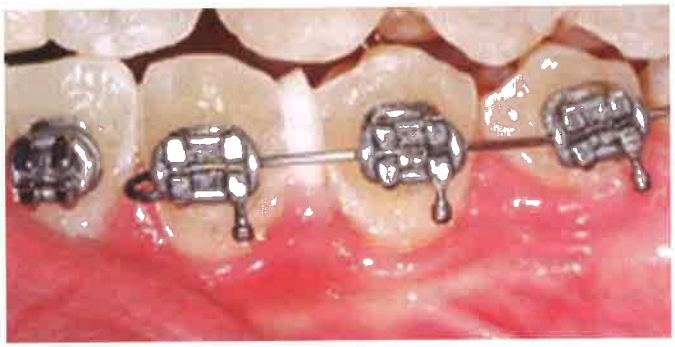


Fig. 9.16 Removable separators are well accepted in the molar and premolar regions, but patients find them more troublesome among the incisors. The doughnut shaped type seem to be more comfortable than the type stamped out from a sheet, as seen here.

Fig. 9.17 The Elliott Anterior Straight Separator is a good alternative to removable elastomeric separation.

Fig. 9.18 The Elliott Separator is particularly useful when teeth are not overlapped. Topical anaesthetics can be helpful and the effect of pressure anaesthesia also reduces discomfort.

Methods of enamel removal

Methods for interproximal enamel reduction include manual abrasive strips, oscillating segmental disks, and motor-driven abrasive strips. Additionally, a wide range of IPR burs is available from the companies. Orthodontists have their individual preferences, and it is beyond the scope of this text to give full details on this topic. Tapered diamond burs are commonly used for IPR, and many types are available. The Patterson ultrasharp diamond bur #088-0104 (Fig. 9.19) can be used for the majority of enamel removal. The Brassler ET3 stripping bur, which is a 0.8 mm carbide bur, can be used to effectively reach tight areas of tooth contact, and can be convenient when separation has not been fully effective.

In the past, rotating diamond discs were used for enamel reduction, but other devices are considered safer and more effective. For example, the Komet OS 30 oscillating contra-angle handpiece, used with an oscillating segment disc (Figs. 9.20 A & B). It was developed by Prof. Dr. Jost-Brinkman in cooperation with Dr. Dreschler. It is a valuable tool for IPR and minimizes the risk of injury to the patient's soft tissue or to operator hands. Like rotary discs, it is used mainly for teeth that are not overlapped. The blades are very thin, and can often be used with minimal separation on more triangular teeth.

Fig. 9.19 A wide range of burs is available for IPR. Here a Patterson ultrasharp diamond bur #088-0104 is being used for the majority of enamel removal on the mesial of the lower right canine. Research has shown that it is difficult to be precise when removing interstitial enamel, and there were large variations between the intended and the actual amounts of enamel reduction. For greater accuracy, a sliding caliper can be used to measure the width of an incisor before and during enamel reduction. Thickness gauges are also helpful.

Figs. 9.20 A & B Interproximal enamel reduction using a Komet oscillating contra-angle handpiece, with copious water. There is minimal risk of injury to the patient's soft tissue or to operator hands. Like rotary discs, this is used mainly for teeth that are not overlapped. The blades are very thin, and can often be used on more triangular teeth when there is minimal separation.

Restoring crown anatomy

The edges of the teeth are often inadvertently sharpened during the main enamel reduction stage, and the shape of the crown is changed (Fig. 9.21). Crowns need to be left with adequate taper after IPR to allow for flossing of the teeth, and generally a one millimeter space left in the gingival area is an adequate minimum in this regard. Round or triangular diamond burs are normally needed to restore the crown shape and remove any sharpness. An example is the Brassler # 8833 bur, which is approximately conical in shape, and is designed to effectively round the edges and any sharp corners after IPR.

Polishing enamel surfaces after IPR

The authors use metal polishing strips for further smoothing of surfaces, and there is a range of products available, both perforated and non-perforated (Fig. 9.22).

It should be noted that scanning electron microscopy (SEM) studies have shown that coarse abrasions are evident after the main enamel removal, and that it is difficult to smooth these [15-18]. However, smoothing is possible. Rossouw and coworkers [17] have suggested the use of polishing strips with small amounts of normal orthodontic etchant. It has been reported [15,16] that the use of 8-straight blade tungsten carbide burs for enamel reduction, followed by fine sand disks for polishing, leaves well-finished surfaces that often appear smoother than the intact or untreated enamel.

At present there are no studies available to compare iatrogenic changes between polished and unpolished enamel surfaces. The landmark papers by Zachrisson and coworkers [3&4] reported that IPR did not lead to iatrogenic damage. Significantly, this research involved the use of a 'careful' protocol, and after enamel reduction the tooth surfaces were polished with fine sand and cuttle 3/4 inch discs.

Accordingly, final polishing is recommended after IPR, using fine sand and cuttle discs.

Fig. 9.21 The corners of the lower left central incisor have been inadvertently sharpened during the main enamel reduction stage, and the shape of the crown has been changed. Round or triangular diamond burs will be used to restore the crown shape. There has been previous IPR on the lower left lateral incisor, and it can be seen that crown shape has been restored.

Fig. 9.22 Scanning electron microscopy (SEM) studies have shown that coarse abrasions are evident after the main enamel removal. Diamond coated metal strips should be used to smooth these, followed by final polishing with fine sand and cuttle discs.

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B2 Bennett J, McLaughlin R P. 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford (ISBN 1 899066 91 8). Republished in 2002 by Mosby, Edinburgh (ISBN 07234 32651)

B3 McLaughlin RP, Bennett JC, Trevisi HJ. 2001 Systemized orthodontic treatment mechanics. Mosby International ISBN 072343171X

Case report AO

This 14 year 2 month old male patient presented as a transfer case. He showed a slight Class II facial and cephalometric pattern, and a related steep occlusal plane. His left posterior segment was 1.5 mm Class II and his right posterior segment was Class I. His anterior bite was edge to edge. His lower incisors and premolars were large and triangular shaped, and his upper lateral incisors were small. The oral hygiene was not good. His panoramic radiograph showed upper incisors with roots tipped mesially and the presence of third molars.

A.O.
BEGINNING
16.2 yrs

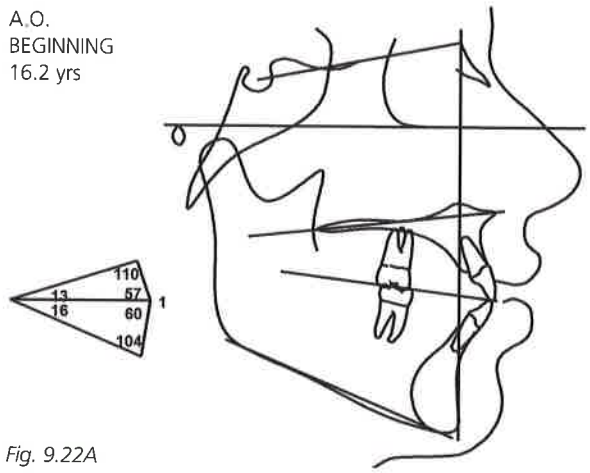

Fig. 9.22A

SNA 86°
SNB 79°
ANB 7°
A-N ⊥ FH 7 mm
Po-N ⊥ FH 0 mm
WITS 1 mm
GoGn SN 31°
FM 23°
MM 29°
↑1 to APo 7 mm
↓1 to APo 7 mm
↑1 to Max Plane 110°
↓1 to Mand Plane 104°

A.O.
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16.2 yrs

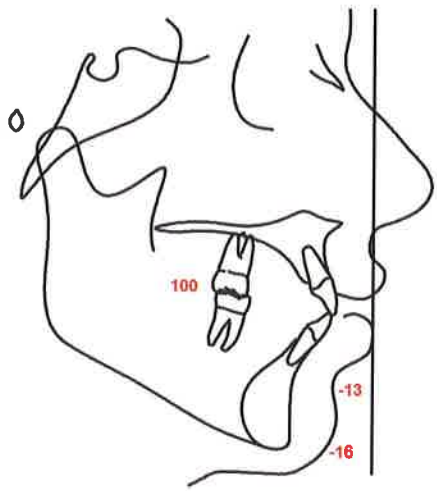


Fig. 9.22B

↑ Incisor torque to occl. plane 57°
↑ Incisor tip to TVL -13 mm
↑ Lip thickness 18 mm
↑ Lip to TVL 4 mm

Max. anterior height 28 mm
↑ Lip length 23 mm
↑ Incisor exposure 5 mm
Inter-labial gap 5 mm

Occlusal plane to TVL 100°
↓ Incisor torque to occl. plane 61°
↓ Lip thickness 15 mm
↓ Lip to TVL 0 mm
Soft tissue 'B' point -13 mm
Soft tissue pogonion -16 mm

Cephalometrically, the patient's upper incisor position and lip thickness were satisfactory. His lower incisors were angled forward at 104° to the mandibular plane.

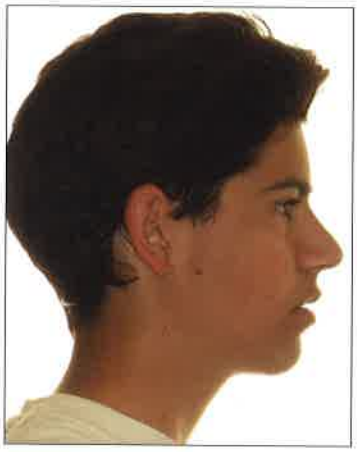


Fig. 9.23

Fig. 9.24

Fig. 9.25

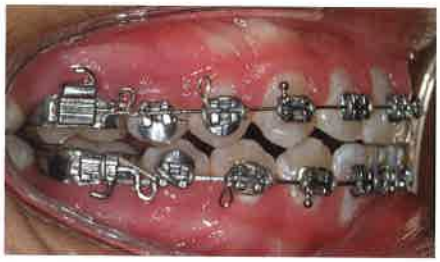


Fig. 9.26

Fig. 9.27

Fig. 9.28

Fig. 9.29

Fig. 9.30

Fig.9.31

Appliances were removed to check the dentition and for hygiene improvement. New appliances were placed using indirect bonding, with the patient preferring esthetic brackets on the upper arch. Tubes were not placed on second molars, due to the patients high angle and his slight anterior open bite. Opal Seal (page 72) was carefully applied to the buccal surfaces of all teeth (Fig. 9.35 on a different patient) to reduce the risk of enamel decalcification, given the patient's history.

Fig. 9.32

The main goal of treatment was to retrocline the lower anterior segment for correction of overjet and overbite. Interproximal enamel reduction (IPR) was recommended from the mesial of the lower right first premolar to the mesial of the lower left first premolar. The possible need for lower premolar IPR and upper lateral bonding, later in the treatment, was also discussed.

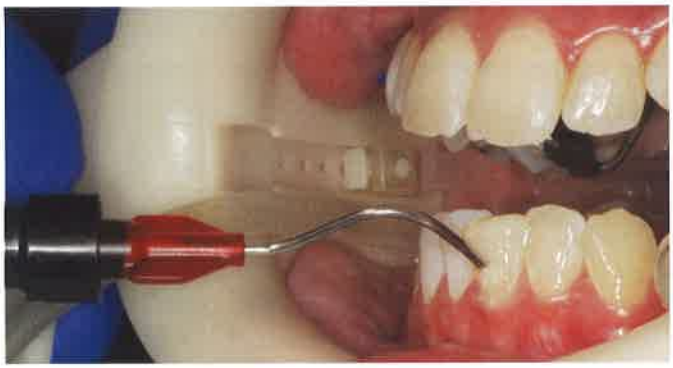


Fig. 9.35 Opal seal (different patient).

An .016 HANT wire was placed in the upper arch. Steel .014 sectional wires were placed in the lower arch from first molars to canines, and separators were placed between the lower canines and first premolars to create space for IPR.

Fig. 9.38A

After the first enamel reduction between the lower first premolars and canines, a laceback was added to each side beneath the sectional wires to close the resulting space. Separators were placed between lower canines and lateral incisors (Fig. 9.39).

Four or five days later, IPR was carried out between lower lateral incisors and canines (Fig. 9.38B and 9.42). Surfaces were polished and separators were placed between lower central and lateral incisors (Fig. 9.41).

Fig. 9.38B

Fig. 9.33

Fig. 9.34

Fig. 9.36

Fig. 9.37

Fig. 9.39

Fig. 9.40

Fig. 9.41

Fig. 9.42

After IPR between the lower central and lateral incisors, surfaces were polished and a separator was placed between the lower central incisors (Fig. 9.44). Elastomeric modules were placed on the lower incisor brackets during the IPR sequence of appointments, for patient comfort.

Fig. 9.43

Finally, IPR was possible in the area between the lower central incisors, and the surfaces were polished. Good patient cooperation is needed for successful IPR, as can be seen from the above sequence of photos (Figs. 9.38 - 9.48), and it is important to explain this during treatment planning. Often the separating elastics cause discomfort, and can be difficult to keep in place.

Fig. 9.46

After the final session of IPR, between the lower central incisors, and polishing of the enamel surfaces, lacebacks were discontinued, and a full .016 HANT wire was placed in the lower arch with bendbacks.

The integrity of the Opal Seal covering was checked every two or three appointments using a special black light.

The lower archwire sequence was:

- Sectional .014 steel wires
- Full .016 HANT wire
- Rectangular .019 / .025 HANT wire
- Rectangular .019 / .025 steel wire
- Full .016 HANT wire (one week)

Fig. 9.49

Fig. 9.44

Fig. 9.45

Fig. 9.47

Fig. 9.48

Fig. 9.50

Fig. 9.51

Fig. 9.52

Fig. 9.53

Levelling and aligning, and overbite control

Six weeks later, upper and lower .0195 / .025 HANT wires were placed, and this was a turning point in the treatment. A main aim of the treatment was to correct the torque among the lower incisors. Space has been created for this, and the required tooth movements were seen in response to the accurately manufactured lower incisor brackets with -6° torque, and the precise archwire used (Fig. 9.57).

Fig. 9.54

Progress review

Levelling and aligning was almost completed at this point, and this is normally a good moment to have a 'progress review' of the case (page 146).

It can be seen that OH was not good, with plaque evident in many areas (Figs. 9.54 – 9.56). However, at the end of treatment the labial enamel was in good condition (Figs. 9.71 – 9.75).

Fig. 9.57

The case progressed to .0195 / .025 steel wires, with light elastic chains to close minor spaces in the lower arch. A right side Class II elastic (1/4 inch 6 oz.) was used. Triangular elastics (1/4 inch 6oz.) were used for anterior bite closure.

In most treatments the .0195 / .025 steel wires have soldered hooks. In this case the upper wire is being used without hooks (for OH reasons) and elastics are attached to Kobyashi wires.

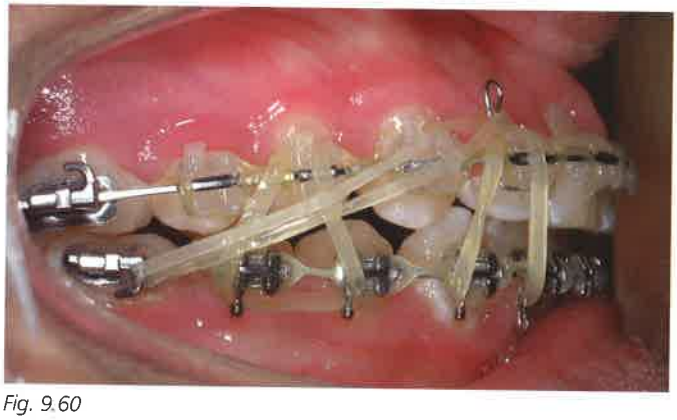


Fig. 9.60

Finishing and detailing

An upper .014 steel round wire was placed from canine to canine, and triangular settling elastics (1/4 inch 6 oz.) were started to the upper laterals and upper canines. The lower .0195 / .025 steel wire was continued for extended settling of 4 to 6 weeks.

At the next visit, a lower .016 HANT wire was placed for one week to allow the lower arch form to settle. Triangular elastics were worn only at night. After one week, retainer impressions were taken, and appliances removed one week later.

Fig. 9.63

Fig. 9.55

Fig. 9.56

Fig. 9.58

Fig. 9.59

Fig. 9.61

Fig. 9.62

Fig. 9.64

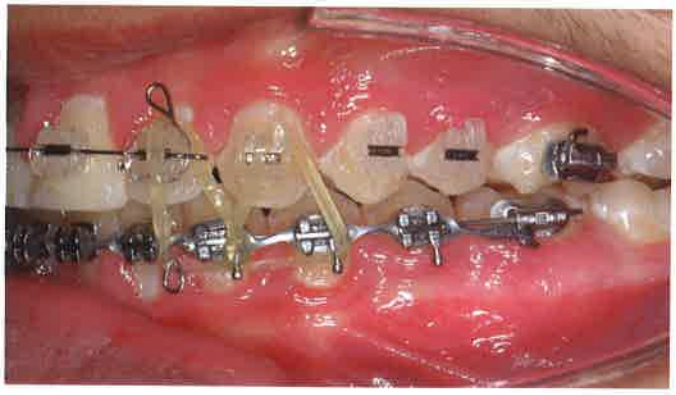
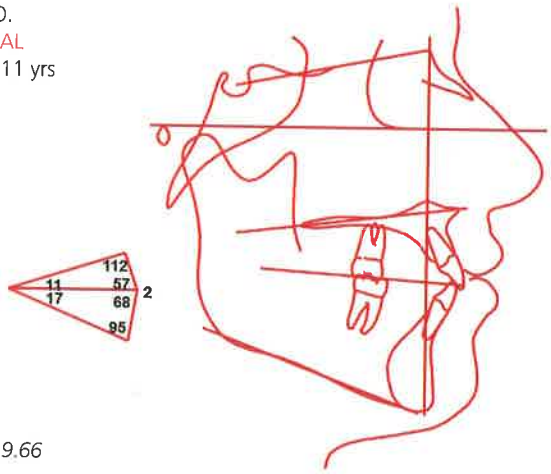


Fig. 9.65

The final intra-oral photographs show a Class I occlusion with adequate overbite and overjet. Third molars are present and possible removal will be discussed with the patient. No IPR was required distal to the lower first bicuspids, and no bonding was needed to build up the upper lateral incisors. The use of Opal Seal was effective in protecting the labial enamel, which was in good condition, despite periods of poor plaque control during the treatment (Figs. 9.71 - 9.75).

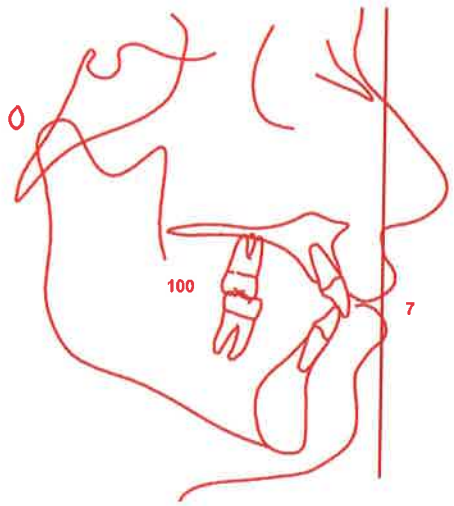
A.O.
FINAL
16.11 yrs



SNA 85°
SNB 80°
ANB 5°
A-N ⊥ FH 8 mm
Po-N ⊥ FH 3 mm
WITS 2 mm
GoGn SN 29°
FM 21°
MM 28°
↑1 to APo 8 mm
↓1 to APo 5 mm
↑1 to Max Plane 112°
↓1 to Mand Plane 95°

Fig. 9.66

A.O.
FINAL
16.11 yrs



↑ Incisor torque to occl. plane 55°
↑ Incisor tip to TVL -12 mm
↑ Lip thickness 17 mm
↑ Lip to TVL 4 mm

Max. anterior height 29 mm
↑ Lip length 22 mm
↑ Incisor exposure 7 mm
Inter-labial gap 4 mm

Occlusal plane to TVL 100°
↓ Incisor torque to occl. plane 66°
↓ Lip thickness 15 mm
↓ Lip to TVL 1 mm
Soft tissue 'B' point -8 mm
Soft tissue pogonion -9mm

Fig. 9.67

The final facial photographs and cephalometric tracings show a slight Class II facial pattern with a satisfactory upper incisor position and good upper lip position. The lower incisors were 10° more upright due to lower IPR and uprighting torque of -6°.

Fig. 9.68

Fig. 9.69

Fig. 9.70

Fig. 9.71

Fig. 9.72

Fig. 9.73

Fig. 9.74

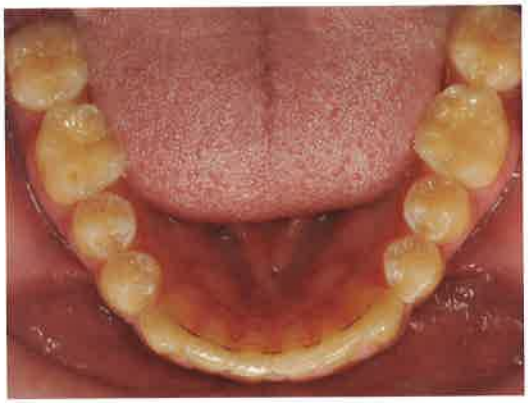


Fig. 9.75

Fig. 9.76

Case report DR

This 31 year 4 month old male was a transfer case. The photographic and cephalometric records showed a slight Class II facial and skeletal pattern with an increased mandibular plane angle. There was some prominence of the lower lip, related to the proclination of the lower incisors and the presence of orthodontic brackets. This case is similar to the previous case but there are important differences in the way it was treated.

Cephalometrically, the upper incisors were at 119° to the maxillary plane, and the upper lip was thin. The mandible was retrusive, and the lower incisors were proclined forward at 108° to the mandibular plane. The intra-oral photographs showed a Class 1 posterior relationship.

The lower first molars had large porcelain crowns, and molar bands were in place, which added to the space occupied by these teeth. The upper second premolars were relatively small, compared with the lower second premolars.

The incisor relationship was edge to edge, and the lower incisors were large and triangular in shape.

The panoramic radiograph showed a healthy dentition with root canal therapy and crowns on the lower first molars. Third molars were absent.

D.R.
BEGINNING
31.4 yrs

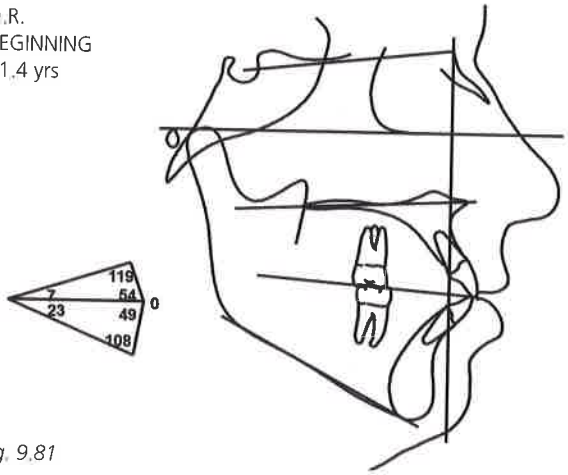


Fig. 9.81

SNA 84°
SNB 82°
ANB 2°
A-N ⊥ FH 0 mm
Po-N ⊥ FH -5 mm
WITS 0 mm
GoGn SN 30°
FM 28°
MM 31°
↑1 to APo 12 mm
↓1 to APo 11 mm
↑1 to Max Plane 119°
↓1 to Mand Plane 108°

D.R.
BEGINNING
31.4 yrs

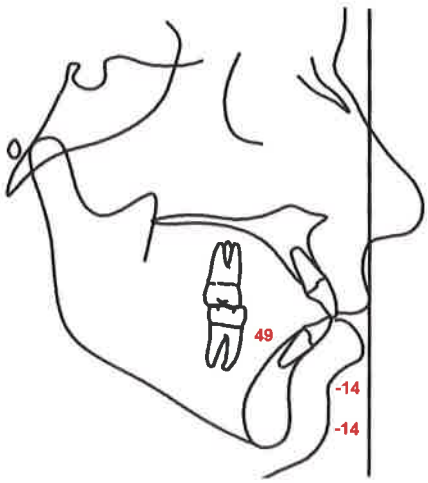


Fig. 9.82

↑ Incisor torque to occl. plane 54°
↑ Incisor tip to TVL -12 mm
↑ Lip thickness 12 mm
↑ Lip to TVL 0 mm

Max. anterior height 26 mm
↑ Lip length 24 mm
↑ Incisor exposure 1 mm
Inter-labial gap 2 mm

Occlusal plane to TVL 95°
↓ Incisor torque to occl. plane 49°
↓ Lip thickness 16 mm
↓ Lip to TVL -2 mm
Soft tissue 'B' point -14 mm
Soft tissue pogonion -14 mm

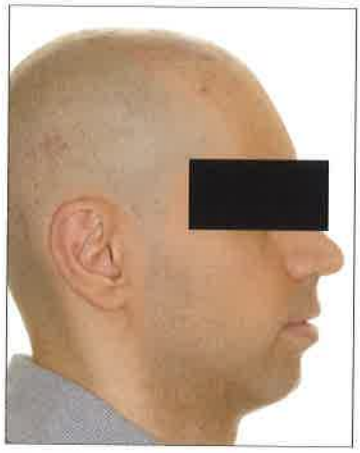


Fig. 9.83

Fig. 9.84

Fig. 9.85

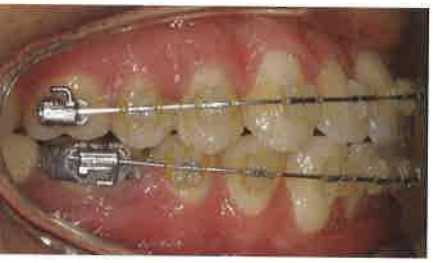


Fig. 9.86

Fig. 9.87

Fig. 9.88

Fig. 9.89

Fig. 9.90

Fig.9.91

Appliances were removed, including lower molar bands. Because there was a significant posterior tooth size discrepancy, IPR was carried out on the mesial of the lower first molars, and the mesial and distal of the lower second premolars. All teeth were bonded, using indirect bonding and ceramic brackets without metal slots. Space was gained in the lower molar region by taking off the molar bands and enamel and porcelain removal among molars and premolars.

Indirect bonding is particularly useful when using clear brackets. Accurate positioning of clear brackets is more difficult when direct bonding, because they tend to 'disappear' as they are placed on the tooth surface. Repositioning of clear brackets should be avoided if possible, because removal and replacement is more difficult and expensive than with metal brackets.

The latest ceramic materials show greater strength than previously, and any notching effect can be reduced or eliminated in the bracket design, by more rounding of the edges of the slots. In addition, notching is not of great concern in most non-extraction cases, because there is little or no sliding mechanics involved.

In this case HANT .0195 / .025 wires with a coating of tooth colored material were used. This combination of clear brackets and tooth colored wires is well received by patients, who are often very concerned about esthetics, particularly in the first three to four months of treatment.

The porcelain crown on the lower right first molar was (1) etched for one minute with Ultradent Porcelain Etch and Silane followed by (2) Opal Seal in the normal bonding protocol. As an additional measure, the crown can be micro-etched before steps #1 and #2.

Only a small amount of IPR was needed in the lower anterior segment, to correct the triangular shape of the incisors. Wires progressed to the normal steel .0195 / .025. Light, clear elastic chains were used for the final space closure, and Class III elastics (one quarter inch 6 ounce) were used to correct the edge to edge bite, achieving a normal incisor relationship.

Before appliance removal, settling was accomplished using an .014 steel sectional and a lower .0195/.025 steel wire, in conjunction with triangular elastics. See chapter 12 for more details on settling.

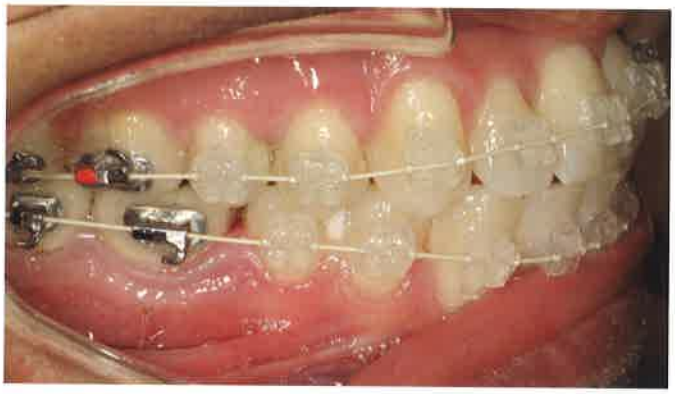


Fig. 9.92

Fig. 9.95 Indirect bonding (on a different patient)

Fig. 9.98

Fig. 9.101

Fig. 9.93

Fig. 9.94

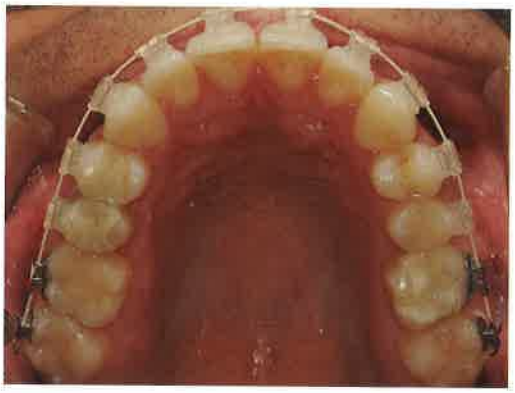


Fig. 9.96

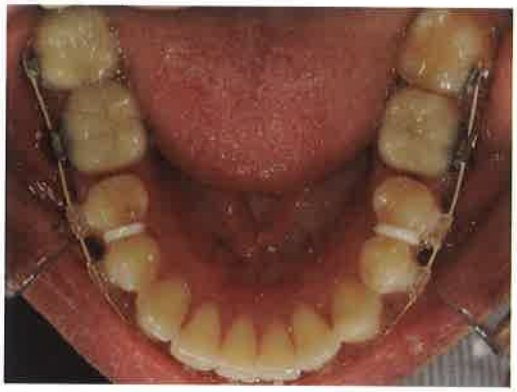


Fig. 9.97

Fig. 9.99

Fig. 9.100

Fig. 9.102

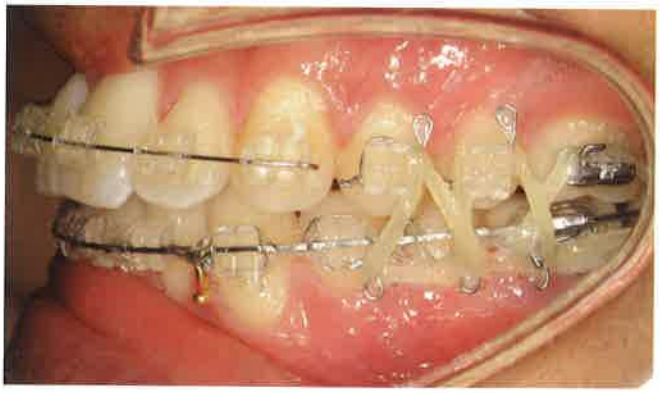
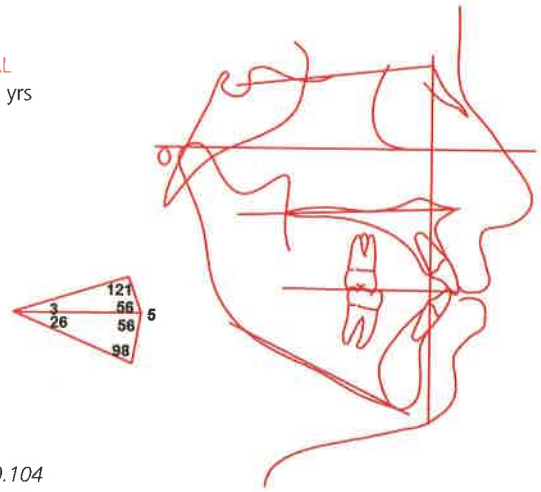


Fig. 9.103

The intraoral photographs showed Class I posterior segments and satisfactory overbite and overjet. The panoramic radiograph showed good root parallelism.

Final facial photos and cephalometric tracings show a minimal effect on the facial profile, but a slight improvement in facial harmony. Upper incisor torque was increased by 2°, and lower incisor torque was reduced by 10°.

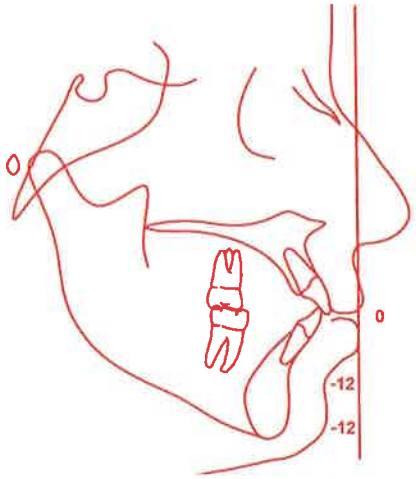
D.R.
FINAL
32.3 yrs



SNA 85°
SNB 82°
ANB 3°
A-N ⊥ FH 2 mm
PO-N ⊥ FH -3 mm
WITS 5 mm
GoGn SN 29°
FM 26°
MM 29°
↑1 to APo 11 mm
↓1 to APo 8 mm
↑1 to Max Plane 121°
↓1 to Mand Plane 98°

Fig. 9.104

D.R.
FINAL
32.3 yrs



↑ Incisor torque to occl. plane 55°
↑ Incisor tip to TVL -11 mm
↑ Lip thickness 13 mm
↑ Lip to TVL 2 mm

Max. anterior height 24 mm
↑ Lip length 24 mm
↑ Incisor exposure 0 mm
Inter-labial gap 2 mm

Occlusal plane to TVL 93°
↓ Incisor torque to occl. plane 55°
↓ Lip thickness 14 mm
↓ Lip to TVL 0 mm
Soft tissue 'B' point -12 mm
Soft tissue pogonion -12 mm

Fig. 9.105

Fig. 9.106

Fig. 9.107

Fig. 9.108

Fig. 9.109

Fig. 9.110

Fig. 9.111

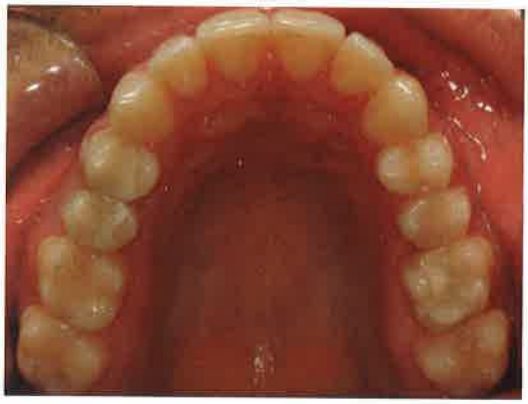


Fig. 9.112

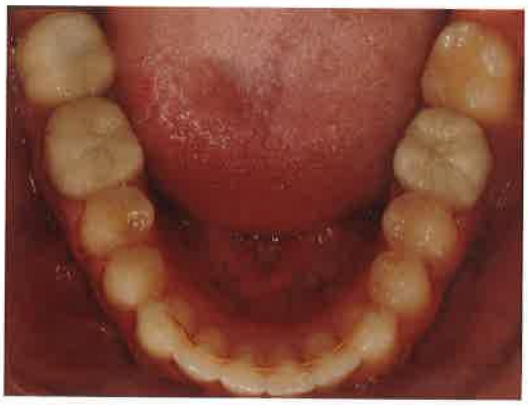


Fig. 9.113

Fig.9.114

Case report RL

This 13 year 3 month old female presented with a Class I facial and skeletal pattern. Her upper and lower incisors were retroclined, her upper lip thickness was greater than normal, and her lower lip thickness was normal. Her posterior dental relationship was Class I, and she had a deep overbite, with crowding in the lower anterior segment and triangular shaped lower incisors. There was a high lip line, and the malocclusion showed the anterior features of a Class II/2 malocclusion, particularly on the right side.

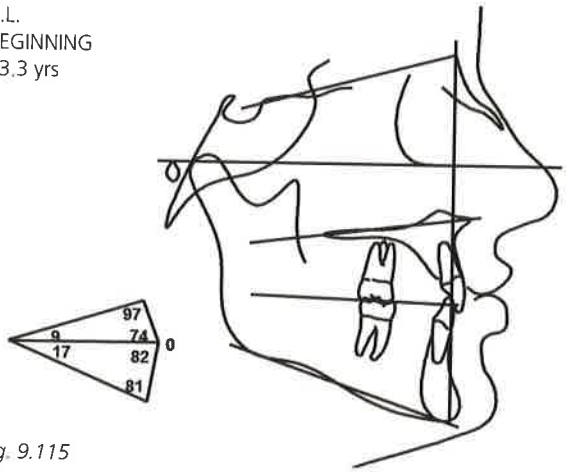


Fig. 9.115

SNA 76°
SNB 75°
ANB 1°
A-N ⊥ FH 0 mm
Po-N ⊥ FH 2 mm
WITS 0 mm
GoGn SN 31°
FM 19°
MM 26°
↑1 to APo 1 mm
↓1 to APo -2 mm
↑1 to Max Plane 97°
↓1 to Mand Plane 81°

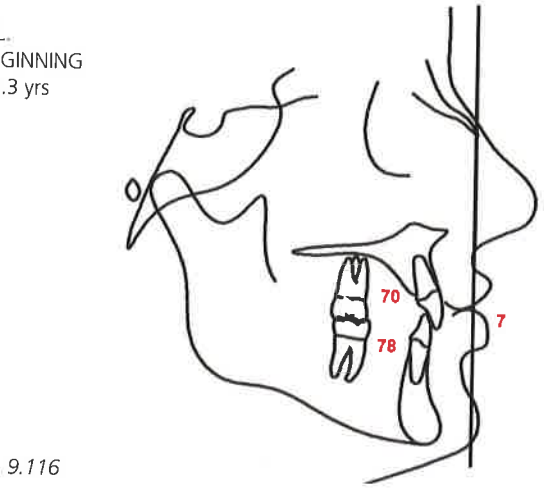


Fig. 9.116

Incisor torque to occl. plane 70°
Incisor tip to TVL -12 mm
Lip thickness 16 mm
Lip to TVL 5 mm

Max. anterior height 25 mm
Lip length 18 mm
Incisor exposure 7 mm
Inter-labial gap 0 mm

Occlusal plane to TVL 94°
Incisor torque to occl. plane 78°
Lip thickness 14 mm
Lip to TVL 4 mm
Soft tissue 'B' point -3 mm
Soft tissue pogonion 2 mm

Fig. 9.117

Fig. 9.118

Fig. 9.119

Fig. 9.120

Fig. 9.121

Fig. 9.122

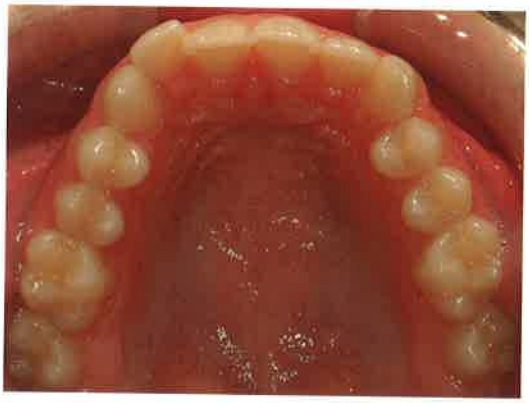


Fig. 9.123

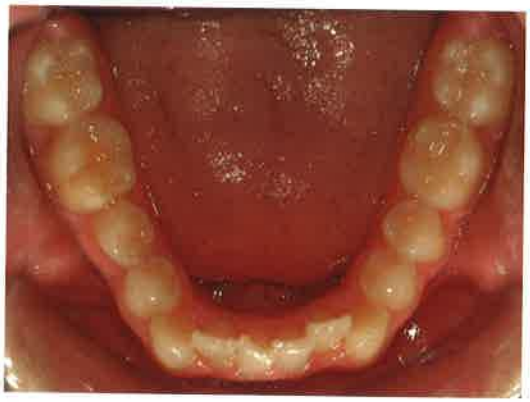


Fig. 9.124

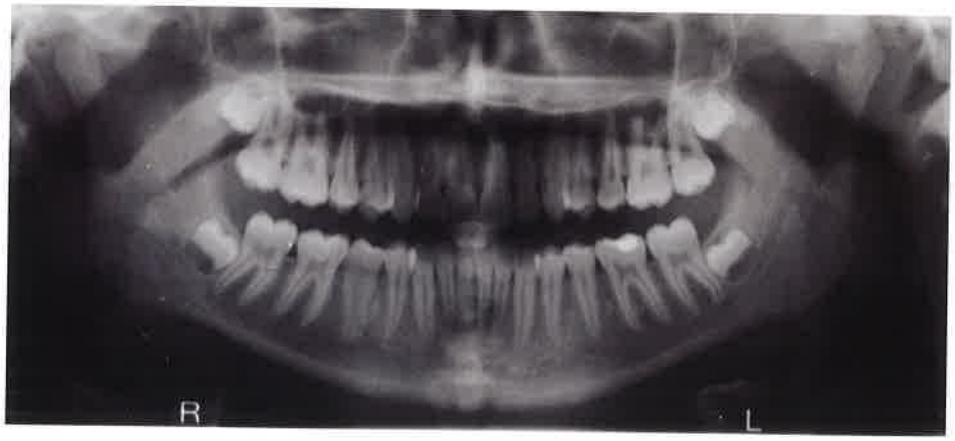


Fig.9.125

Upper arch levelling and aligning. Lower arch IPR

Brackets and tubes were placed on the upper teeth, using indirect bonding, and an .016 HANT wire was placed to start levelling and aligning. Brackets were bonded on to the lower posterior teeth, except for the rotated lower right second premolar, and sectional .016 HANT wires were placed. Separators were placed distal to the canines, and were left in place for four to five days.

Turbos were not required for this case because there were no lower bracket interferences. However, if there are tooth interferences, or if there is a deep overbite, then removable bite planes (Fig. 9.175) or bite turbos (Figs. 9.129 & 9.178) can be useful.

In low angle deep bite cases, turbos are most effective in the upper anterior area. In high angle deep bite cases, which are seen less frequently, they are often most beneficial on the mesio-palatal cusps of the upper first molars, and if needed, also on the mesio-palatal cusps of the upper second molars (Fig. 9.178). Turbos can be progressively reduced in size and eliminated as bite opening occurs.

A .016 / .022 HANT wire was placed in the upper arch to continue levelling and aligning (Figs. 9.132, 9.133, & 9.134). IPR was carried out between the lower canines and first premolars, and then separators were placed between the lower canines and lower lateral incisors for four to five days.

At the following visit (not shown) IPR was carried out between the lower canines and lower lateral incisors. Separators were then placed between the lower lateral incisors and lower central incisors. During this time, treatment continued in the upper arch, using the .016 / .022 HANT wire.

Fig. 9.126

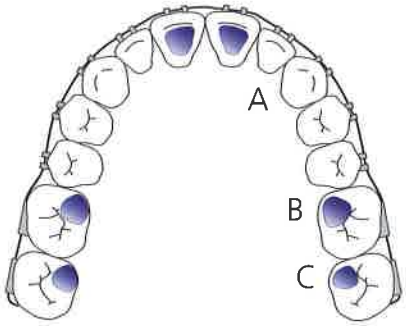


Fig. 9.129 Turbos can be used on central incisors (A) for low angle cases, or on molars (B & C) for high angle cases.

Fig. 9.132

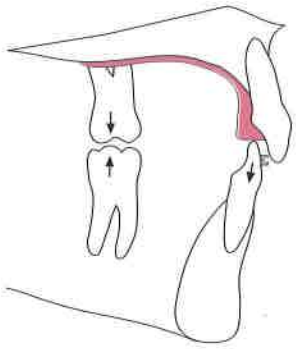


Fig. 9.135 A removable bite plane can be useful in the early stages of bite opening if there are incisor interferences.

Fig. 9.127

Fig. 9.128

Fig. 9.130

Fig. 9.131

Fig. 9.133

Fig. 9.134

Fig. 9.136

Fig. 9.137

Continuation of levelling and aligning, and the beginning of overbite control

The necessary IPR was completed on the lower lateral and central incisors. Brackets were then bonded on to the lower incisors and the lower right second premolar, and a full arch .016 HANT wire was placed. The lower incisor brackets were inverted in this case, to encourage the necessary torque changes (Fig 9.173). This inversion can be more clearly seen in Fig. 9.154 and is one of the different uses of brackets, as discussed in chapter five. It is beneficial to have tubes on the lower second molars at this time, to help in the bite opening process, as levelling occurs (Fig. 9.141).

The .016 / .022 HANT wire remained in the upper arch, and it can be seen that good alignment is occurring.

Fig. 9.138

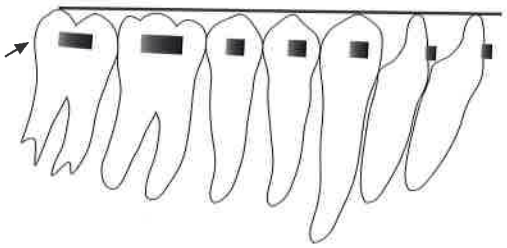


Fig. 9.141 It is beneficial to include lower second molars during the bite opening process. In most cases it is essential.

At the next visit the case progressed to an upper .0195 / .025 HANT wire (Figs. 9.144, 9.145 & 9.146). The .016 HANT wire was lightly retied in the lower arch (Fig. 9.149).

Authors' note:
Turbos and removable bite planes are not popular with patients. The turbos interfere with normal occlusion, and it is necessary to justify the need for them to the patient. A removable bite plane can be difficult to wear, because it is one more appliance item in an already crowded mouth, and as upper teeth align, the fit worsens.

For treating non-growing adults, with deep and long established overbites, turbos or a removable bite plane may be invaluable. For routine cases in children or adolescents, they are normally not needed. One author (JB) treats only non-adults, and seldom finds a need for turbos or removable bite planes for deep bite correction. The other author (RM) uses them in many children and adults with deep bites and/or initial bracket interferences.

Fig. 9.144

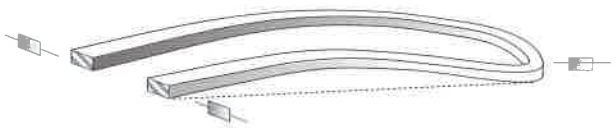


Fig. 9.147 During overbite control, the use of heat treated steel rectangular wires, with a greater modulus of elasticity, reduces the need for bite opening curves.

Fig. 9.139

Fig. 9.140

Fig. 9.142

Fig. 9.143

Fig. 9.145

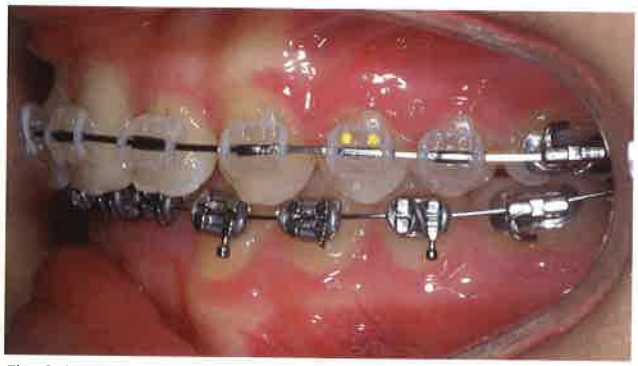


Fig. 9.146

Fig. 9.148

Fig. 9.149

Continuation of overbite control

The .0195 / .025 HANT wire was retied in the upper arch, and a .016 / .022 HANT wire was placed in the lower arch. At this visit lingual buttons were placed on the lower right second premolar and first molar, and a light elastic chain was attached between the two teeth for rotation control (Figs. 9.156 and 9.158).

The .019 / .025 HANT wire was retied in the upper arch. A .019 / .025 HANT wire was placed in the lower arch. Note that the overbite was improving with only the placement of flat archwires. This bite opening effect is partially due to the advancement of incisors.

The lower right first premolar bracket was tied with a wire ligature, to prevent it from rotating, before two links of an elastomeric chain were placed to assist in rotation of the second premolar (Figs. 9.153 & 9.156).

Fig. 9.150

Fig. 9.153

Space closure and minor Class II correction

Here the case is seen with upper and lower .019 / .025 steel wires (Figs. 9.159, 9. 160 & 9.161). This is an excellent time to evaluate tooth size in the upper anterior segment, and to adjust it if needed. The lower arch position has been established with IPR and levelling. The buccal segments are Class I, and the overjet, overbite and anterior tooth mass issues can be clearly seen. At times the tooth fit is ideal. At other times there is a shortage of tooth mass in the upper anterior segment, and bonding is required. Less commonly, the upper tooth mass is excessive, leaving extra overjet, as in this case. Upper arch IPR is then indicated, and in this case it was carried out between the lateral incisors and canines. Active tie-backs were used in the upper arch to close final spaces. A light chain elastic was placed in the lower arch to close final spaces. It can be seen to end at the second premolar on the right, to continue rotation control.

Occasionally, after flat .019 / .025 steel wires have been in place for two visits, the deep bite may not be fully corrected. If necessary, 2 mm to 3 mm bite opening curves can be placed in these arch wires. The use of heat treated steel rectangular wires, with greater stiffness, reduces the need for bite opening curves (Fig. 9.147).

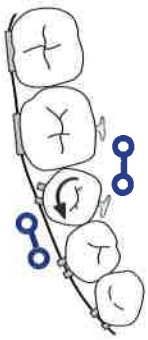


Fig. 9.156 Light elastomeric chains were used to correct the rotated second premolar. The first premolar was tied with a wire ligature to prevent it from rotating.

Fig. 9.159

Fig. 9.151

Fig. 9.152

Fig. 9.154

Fig. 9.155

Fig. 9.157

Fig. 9.158

Fig. 9.160

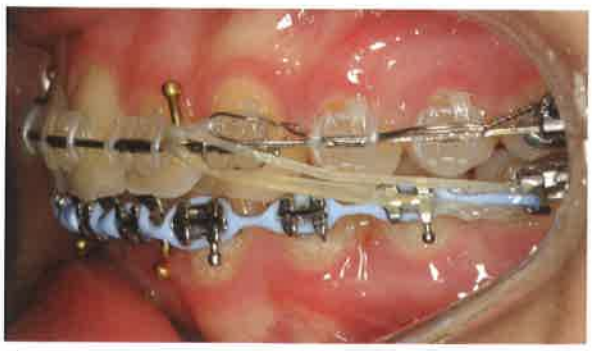
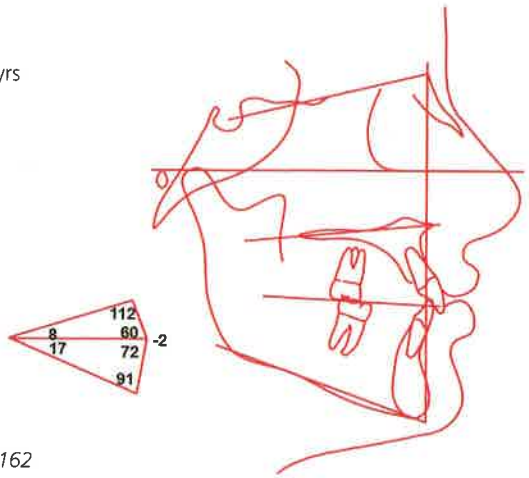


Fig. 9.161

Final intra-oral photos and a panoramic radiograph show a Class I dental relationship with ideal overbite and overjet. Root parallelism is good, and third molars are present and in good position. Facial photographs show improved facial balance. Incisor torque is adequate and the prominence of the chin is less evident.

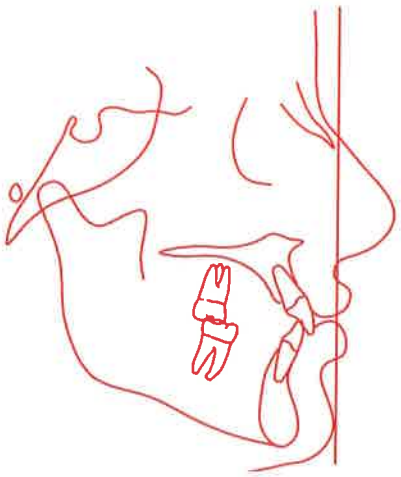
R.L.
FINAL
15.1 yrs



SNA 75°
SNB 75°
ANB 0°
A-N ⊥ FH -2 mm
Po-N ⊥ FH 1 mm
WITS -2 mm
GoGn SN 30°
FM 20°
MM 25°
↑1 to APo 6 mm
↓1 to APo 3 mm
↑1 to Max Plane 112°
↓1 to Mand Plane 91°

Fig. 9.162

R.L.
FINAL
15.1 yrs



Incisor torque to occl. plane 56°
Incisor tip to TVL -8 mm
Lip thickness 15 mm
Lip to TVL 5 mm

Max. anterior height 25 mm
Lip length 18 mm
Incisor exposure 6 mm
Inter-labial gap 2 mm

Occlusal plane to TVL 97°
Incisor torque to occl. plane 67°
Lip thickness 13 mm
Lip to TVL 3 mm
Soft tissue 'B' point -5 mm
Soft tissue pogonion -1mm

Fig. 9.163

Authors' note:
In this deep bite case the upper arch was aligned first, which moved the upper incisors away from the lowers. The lower arch was then aligned, without the need for turbos or a removable bite plane, and Class II elastics were used to correct the small overjet.

This is an accepted and useful approach to this type of malocclusion, but only in cases where there is probably some growth to come, and where the A/P dental base relationship is Class I (as here) or mild Class II. Care is needed in case selection, because this approach is not suitable for most adult Class II/2 malocclusions, or for adolescents if there is a retrognathic mandible.

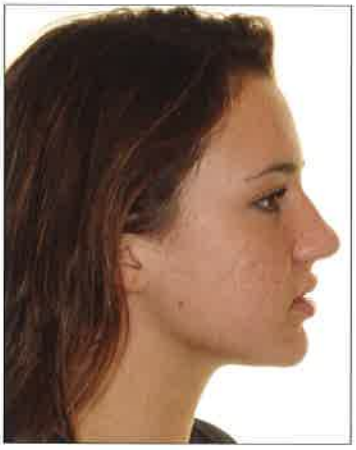


Fig. 9.164

Fig. 9.165

Fig. 9.166

Fig. 9.167

Fig. 9.168

Fig. 9.169

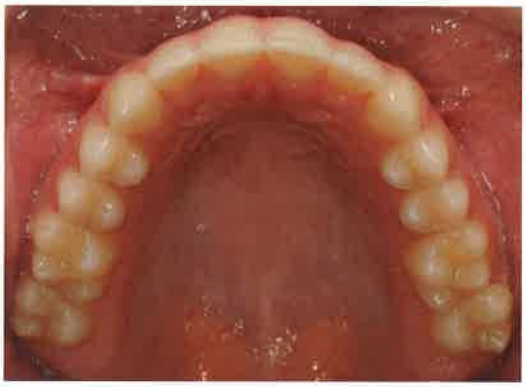


Fig. 9.170

Fig. 9.171

Fig.9.172

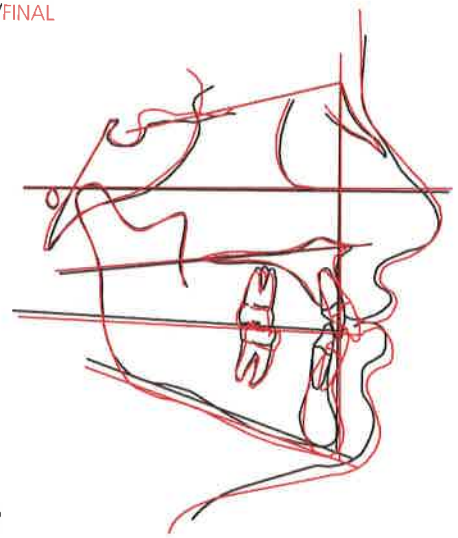


Fig. 9.173

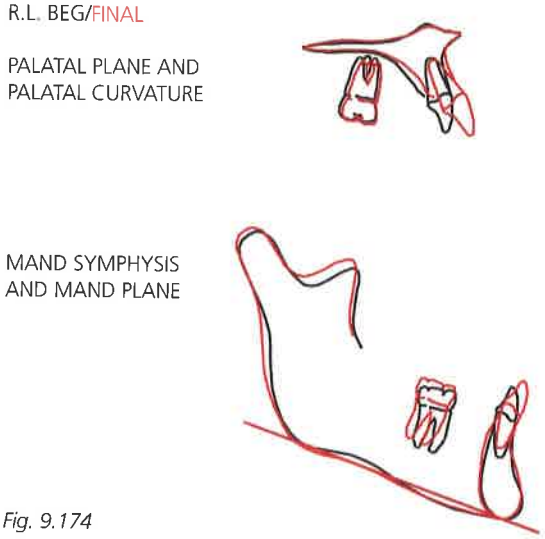


Fig. 9.174

Superimpositions show the slight advancement of incisors, and the improved soft tissue profile.

When treating non-growing adults, with deep and long established overbites, turbos or a removable bite plane are often a great help to the treatment mechanics. Examples are shown below (Figs. 9.175 – 9.178).

Fig. 9.175 A removable bite plane. As the teeth align, the fit of the appliance becomes less good.

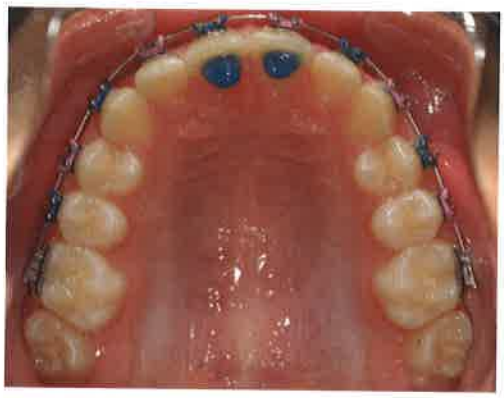


Fig. 9.176 Turbos on incisors in a low angle deep bite case.

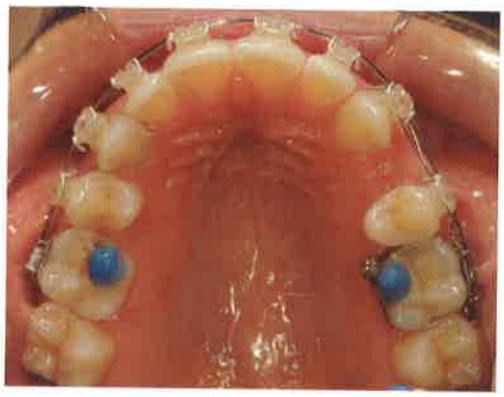


Fig. 9.177 Turbos on upper first molars in a high angle deep bite case.

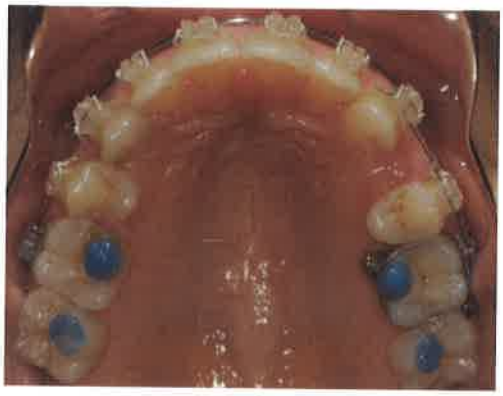


Fig. 9.178 Turbos on upper first and second molars in a high angle deep bite extraction case.

CHAPTER 10

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First premolar extraction treatment and intra-arch mechanics

Introduction

Since the beginning of orthodontics as a specialty, the extraction of premolars has been controversial, and the authors have discussed the main issues in detail in an earlier text (B2 Ch. 5).

Extraction versus non-extraction

In the early 1900s, there was inadequate scientific and clinical evidence to understand the limits of the alveolar processes, relative to tooth movement. Dr. Edward H. Angle [1] proposed that cases should be treated to a Class I molar relationship on a non-extraction basis. Calvin Case [2] disagreed, contending that some cases would benefit from extraction treatment. Angle won the day, and orthodontic cases were mostly treated on a non-extraction basis for nearly 35 years. Over time, there was evidence of relapse and periodontal breakdown after some non-extraction treatments, which supported the need for extractions in some cases. In the mid 1940s, Charles Tweed [3] advocated premolar extractions when there was a discrepancy between tooth size and basal bone, and he showed excellent results on numerous extraction cases. Dr. P. Raymond Begg also favored premolar extractions [4] maintaining that it was scientifically correct, because it simulated the natural attrition of the teeth, as seen in Aboriginal dentitions.

Gnathology concerns in the 1970s

In the 1970s the idea of extraction of premolars was again challenged, this time by the gnathologists, some of whom contended that an ideal functional occlusion could not be achieved if premolars were extracted. Dr. Ron Roth [5] (B2 Ch. 5) reviewed the work of Charles Stuart, the 'father' of gnathology, and emphasized the importance of treating all patients, including premolar extraction cases, to gnathological standards. He and many other orthodontists demonstrated that premolar extraction cases could be treated to ideal gnathological results, as described by Stuart.

Temporomandibular joint issues in the 1980s

In the 1980s, some clinicians contended that premolar extractions led to temporomandibular disorders (TMDs). The premise was that premolar extractions caused a sequence of events in the following order. (i) Premolar extractions led to anterior bite collapse and bite closure. (ii) This created anterior premature contacts, causing distal mandibular displacement. (iii) With the condyle displaced posteriorly, there was greater potential for disc displacement, and the incidence of TMDs was increased (Fig. 10.01). However, numerous correlation studies and clinical investigations failed to support this premise. Today it is accepted that anterior premature contacts will not occur if correct treatment mechanics are used, and the suggested problems above will be avoided.

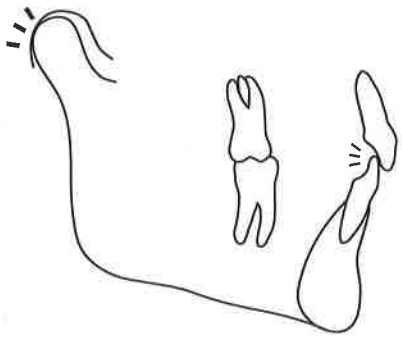

Fig. 10.01 In the 1980s it was contended that premolar extractions led to temporomandibular disorders, due to anterior premature contacts causing distal mandibular displacement. Today it is accepted that such contacts will not occur if correct treatment mechanics are used.

The authors' view on premolar extractions

The authors' view on premolar extractions is as follows:

- It is difficult to treat premolar extraction cases to Andrews Six Keys, American Board of Orthodontics standards, and good functional occlusions. However, cases can be treated to these standards by using pre-adjusted appliances that are well placed, combined with reliable treatment mechanics.
- There are many factors which can cause TMDs, but a main factor is parafunctional activity and general trauma. Over the years there has been uncertainty about the role of malocclusion in causing TMDs, and there are arguments on both sides of the subject.

The confusion arises because traumatic and other etiologic factors are often superimposed on a malocclusion. Thousands of cases with TMDs and malocclusions have been successfully treated with a combined approach. Firstly, there is mechanical and medical stabilization of the muscles and joints, using splints and medications as needed. Secondly, this can be followed by non-extraction and/or extraction treatment with orthodontics alone or with orthognathic surgery. This is a successful treatment approach, and is not just a coincidence. Clearly malocclusion can be a factor, and when corrected, can aid in managing TMDs.

There is reluctance of parents, patients and some dentists to accept the idea of premolar extractions. This may be due to parents or patients having previous bad experiences, or a fear of the process of removing of the teeth. Reluctance from dentists may be due to them seeing disappointing results on patients returning to their offices after extraction treatment. These pressures are brought to every orthodontic practice. However, one of the orthodontist's goals of treatment (page 2) is to manage the patient's chief complaints. Unfortunately, when there is insistence from a patient or a dentist that they do not want premolars extracted, it does not change an extraction case into a non-extraction case. If the crowding is greater than can be managed by appropriate IPR and reasonable dental compensation, extraction treatment is indicated.

The uses of premolar extraction space

The treatment method described in this book was first shown in 1993 (B1) and has been gradually developed and refined in the twenty years since then. It features group movement and sliding mechanics, and these aspects of the technique are most evident in first premolar extraction cases. Like human fingerprints, no two malocclusions are the same, which is one of the fascinations of the orthodontic specialty. Despite this, routine and systemized methods are available to treat typical malocclusions after first premolar extraction, and these can be applied to many cases, as seen in the following pages.

The space obtained from premolar extractions is used for two main purposes.

- With inter-arch mechanics, the space is used to allow incisor torque changes during correction of a Class II or Class III incisor relationship. This helps to reach a normal overjet and overbite, and improved facial profile. This is achieved by varying the anchorage balance during sliding mechanics, normally with intermaxillary elastics or other methods of anchorage support (Chapter 8).
- With intra-arch mechanics (which is the main focus of this book) premolar extraction space is used to manage crowding which is greater than can be treated by appropriate IPR and reasonable dental compensation.

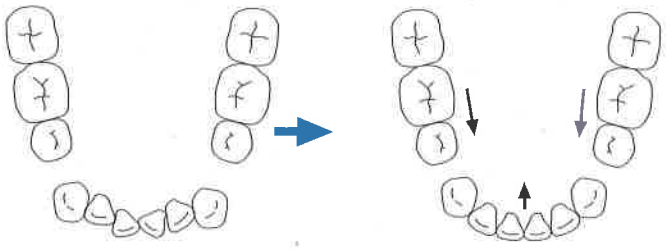

Fig. 10.02 Sliding mechanics are particularly effective in first premolar extraction cases. After tooth alignment, anchorage balance can be managed during space closure, to meet the requirements of the case.

The levelling and aligning phase after first premolar extractions

The first objective in most treatments is tooth levelling and aligning. It may be defined as:

> *The tooth movements needed to achieve passive engagement of a steel rectangular wire of .019 / .025 dimension and of suitable arch form, into a correctly placed and accurately manufactured preadjusted .022 bracket system.*

From the start of treatment, all tooth movements should be carried out with the final treatment goal in mind, and anchorage control should be used to restrict unwanted tooth movements. The term 'anchorage control' during tooth levelling and aligning is defined (B3 p. 94) as follows:

> *The maneuvres used to restrict undesirable changes during the opening phase of treatment, so that levelling and aligning are achieved without key features of the malocclusion becoming worse.*

Levelling and aligning if there is no anterior crowding

If first premolars are extracted in cases with bimaxillary protrusion and minimal crowding, brackets and tubes can normally be placed on all teeth from first molar to first molar, and levelling and aligning can proceed quickly to rectangular steel wires. After that, en masse retraction of the anterior teeth can start (Figs. 10.03 A, B & C). In bimaxillary protrusion cases with some crowding, group movement and sliding mechanics can be used in a similar way, but with appropriate anchorage support, depending on the needs of the case and profile considerations (B1 p. 108 – 117).

After first premolar extractions for orthodontic reasons, it is necessary to decide where the space is to be allocated. The anterior teeth may be uncrowded, for example in the bimaxillary protrusion case shown opposite (Figs. 10.03 A, B & C). On the other hand, there may be mild to severe crowding (Case KE B2 p.222). Different mechanics are needed to deal with the various possibilities, and the following pages show methods which the authors use and recommend.

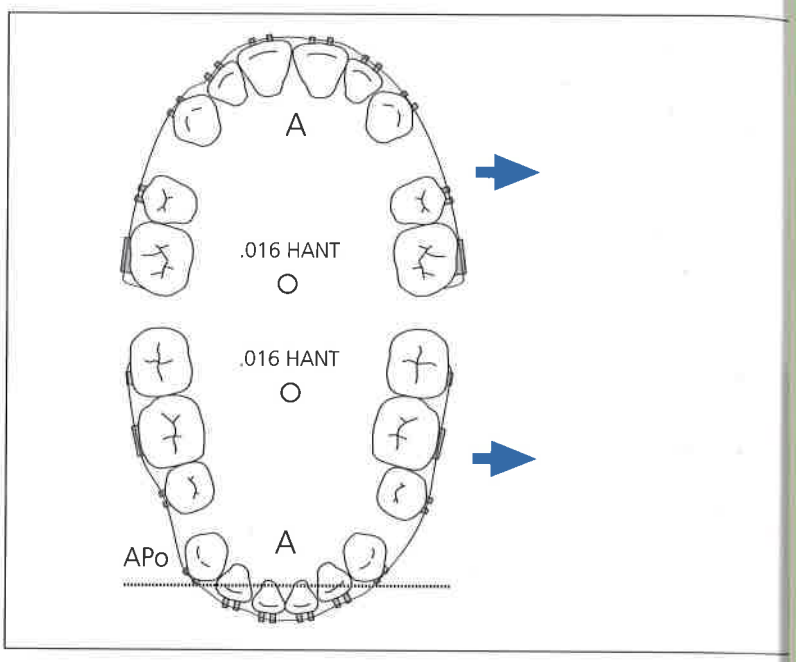

Fig. 10.03 Part A. In cases with bimaxillary protrusion and minimal crowding, levelling and aligning can go quickly through .016 HANT and then .019 / .025 HANT to rectangular steel working wires.

Levelling and aligning after first premolar extractions in cases with mild anterior crowding

In cases with mild anterior crowding, treatment mechanics are similar to the uncrowded cases, but the initial wire may be in place for more than one month. After first premolars have been extracted, brackets and tubes can be placed on all teeth from first molar to first molar. Normal canine lacebacks are placed, but the initial .016 HANT wires are not attached to every wing on all the anterior brackets at the first visit (Fig. 10.04A). When the patient returns after a month, the canines will have dropped slightly into the line of the arch. The lacebacks should be tightened to 'take up the slack', and the HANT wires can be fully engaged into the anterior brackets. Levelling and aligning can then go ahead uneventfully to rectangular steel wires. After that, en masse group movement can begin, depending on the needs of the case. (Figs. 10.04 A, B & C).

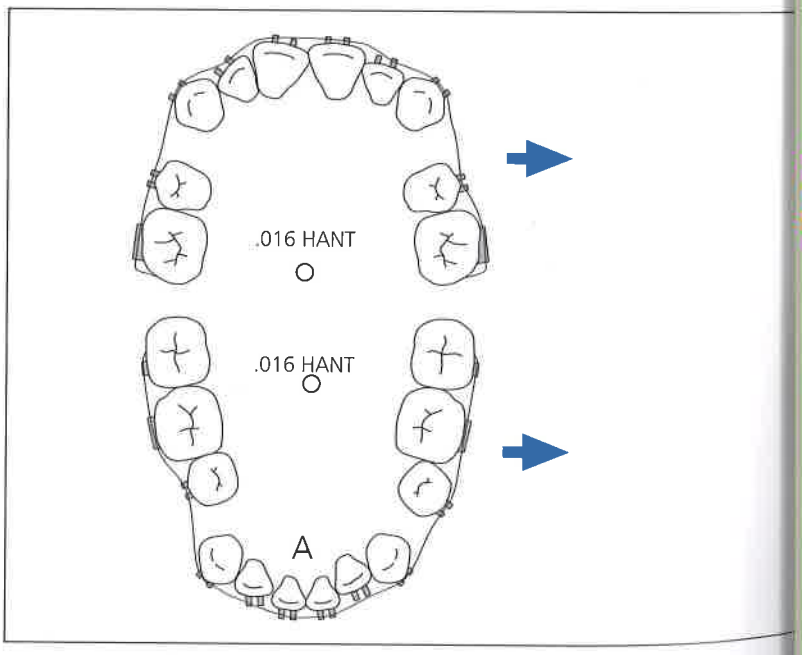

Fig. 10.04 Part A. In cases with mild anterior crowding, levelling and aligning can begin with .016 HANT. Lace backs (not drawn) are used to control canines and support the wire. Bendbacks are needed, and not all wings of all brackets are included at the first visit, to avoid incisor proclination.

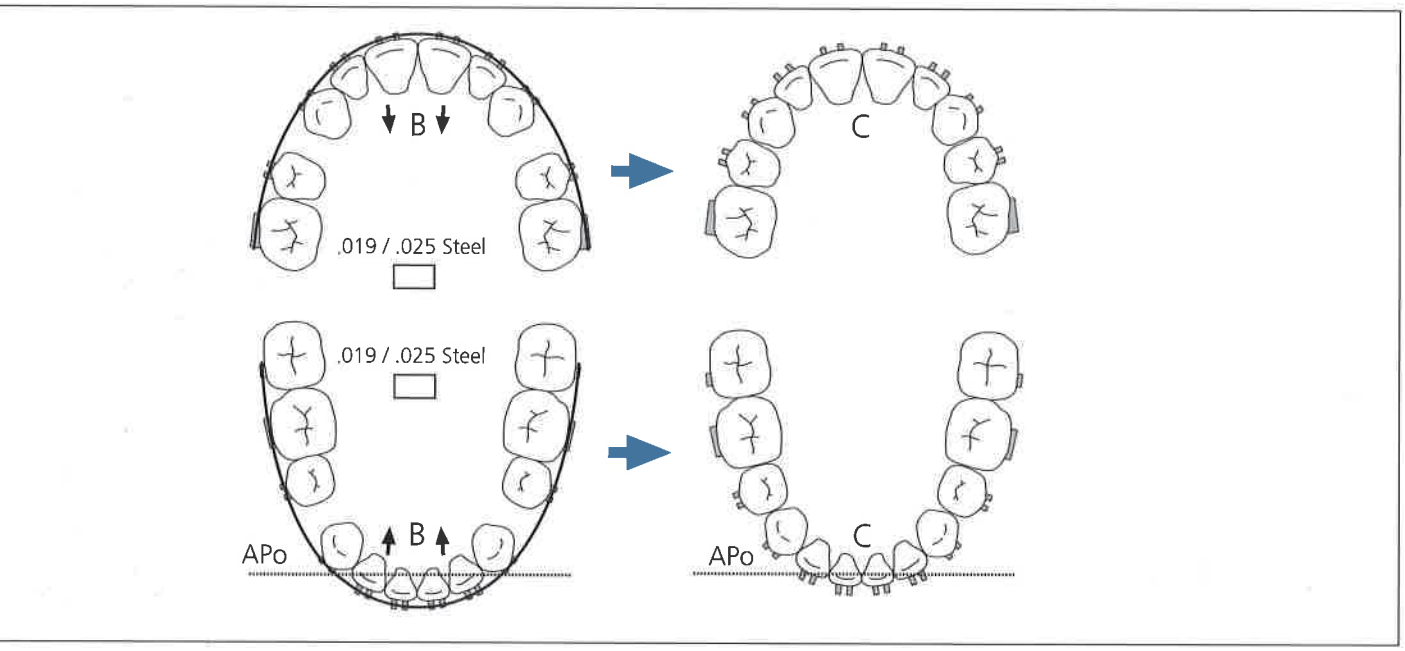

Fig. 10.03 Parts B & C. Lace backs (not drawn) and bendbacks are used for anchorage control of incisors and canine and to support the light wires early in treatment. Steel round wires will be needed if there is a steep curve of Spee. Sliding mechanics are used with .019 / .025 steel wires for en masse retraction of the anterior teeth, relative to APo line. The methods of anchorage support are discussed in chapter 8.

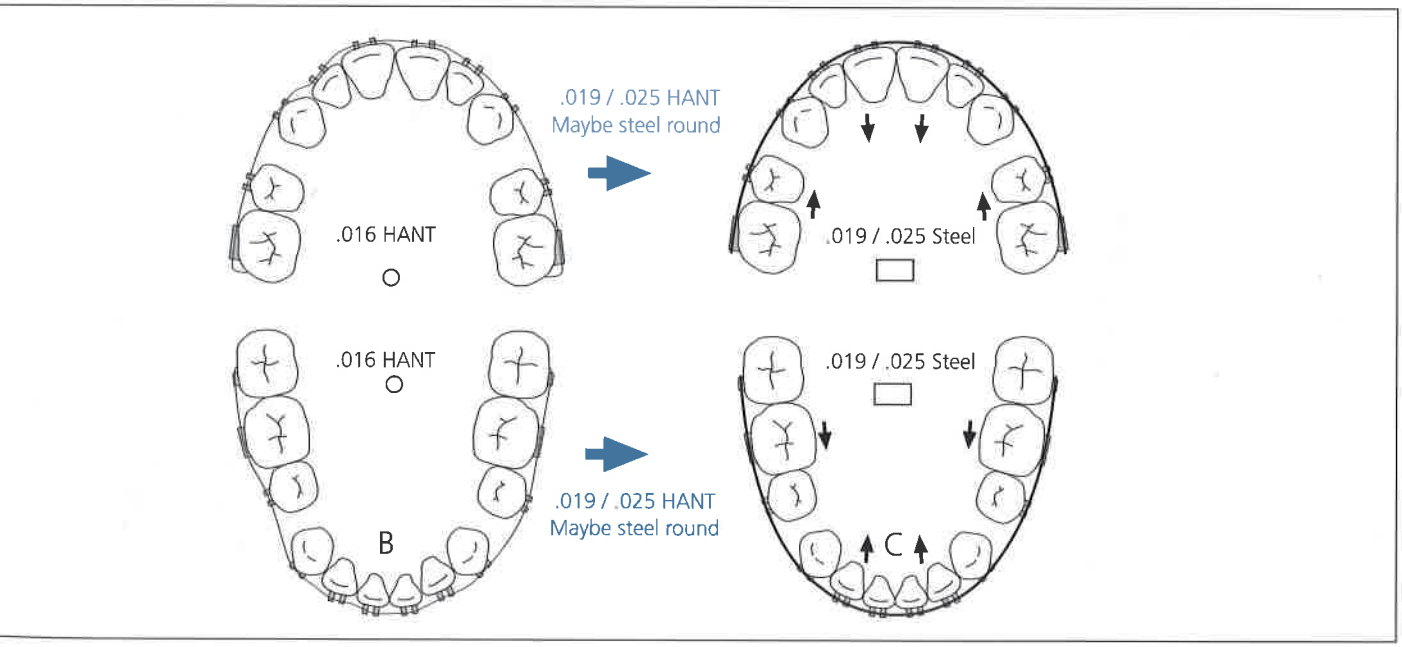

Fig. 10.04 Parts B & C. As the teeth unravel, all the wings of the anterior brackets can be attached to the archwire. Bendbacks prevent an increase in the overjet, and lacebacks (not drawn) control the canines. Levelling and aligning is achieved with .016 HANT and then .019 / .025 HANT, progressing to rectangular steel wires. Steel round wires will be needed if there is a steep curve of Spee. Finally, sliding mechanics are used to meet the needs of the case.

Tipping versus bodily movement

If there is moderate crowding in a first premolar extraction case, the main goal at the start of treatment is to move the canines bodily to eliminate the anterior crowding. The aim is to provide enough space to align the six anterior teeth, but not to move the canines away from the lateral incisors, causing anterior spacing.

Anterior alignment can be achieved by tipping canines and second premolars into the extraction sites, and then uprighting them so that the roots become parallel. This is the method used in the Begg technique, but is not recommended for preadjusted edgewise.

Alternatively, the canines and second premolars can be gently guided towards the extraction sites, with bodily movement, and this is the method used by the authors.

The progressive bodily movement of teeth

Although it appears that space is closing more slowly at the start of treatment, the bodily movement of teeth into extraction sites is recommended. If teeth move bodily this results in less bite deepening, less posterior extrusion, better anchorage control, and reduced treatment time. However, at first there is the impression that the case is making slower progress than with tipping.

The tipping of teeth into extraction sites

The tipping of teeth into extraction sites is not recommended. If canines and second premolars are allowed to tip, the crowns move together more rapidly at the start of treatment, giving the impression that spaces are closing quickly. However, there are associated problems:

- The force created on the arch wires by the tipping of the canines leads to bite deepening, if the incisors are bracketed (B1 p. 10 & 127).
- The posterior teeth tend to extrude as they are tipped forward, as can be seen when a lower second molar is uprighted to create space for a missing first molar. Equilibration is frequently needed on the second molar as uprighting occurs.
- There is anchorage loss because of the tipping forward of the molars. This is due to the loss of the Tweed 'tip back bend' effect. If there is contact between the entire mesial aspect of the roots of the two or three posterior teeth against alveolar bone, this provides considerable resistance to forward movement. This beneficial effect is reduced if there is tipping of the posterior teeth.
- If there is tipping of the canine crown towards the second premolar crown, the apices of the roots of these teeth move apart instead of together. This requires more treatment time to move the roots together.

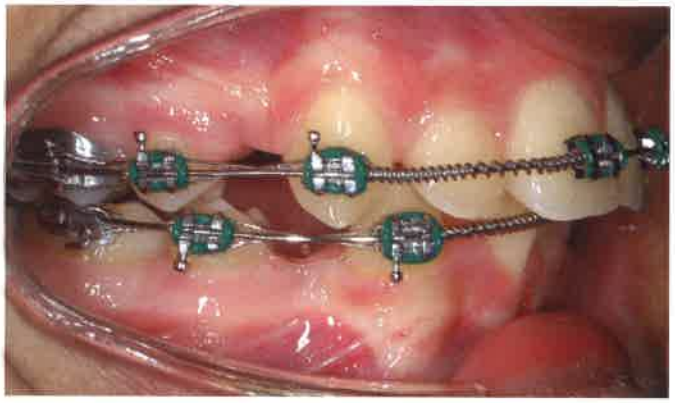

Fig. 10.05 The bodily movement of teeth into extraction sites is recommended, but at first there is the impression that the case is making slower progress than with tipping. The mechanics seen here are discussed on page 190.

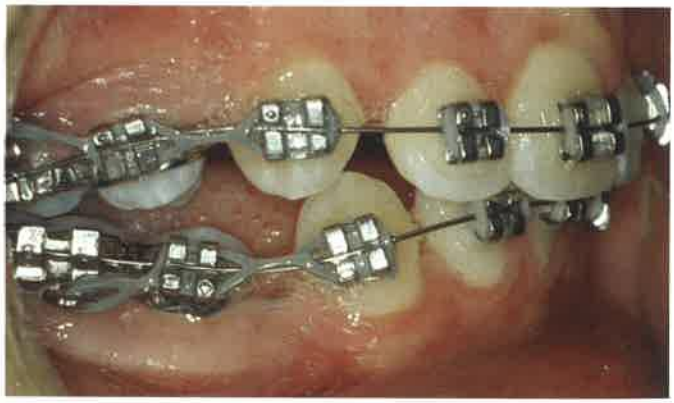

Fig. 10.06 The tipping of teeth into extraction sites is not recommended, as seen in this image. If elastomeric chains are used on light wires, unwanted tooth movements normally occur, and these lengthen the treatment time.

Achieving bodily movement of teeth into extraction sites

Unwanted tipping will occur if heavy forces are used with light, flexible wires, and this can increase the length of treatment. Accordingly, it is recommended to use wires with adequate stiffness, in combination with lighter, intermittent forces from lacebacks. This reduces any tipping tendency.

There should be a focus on arch form stabilization, and the need to move the canines bodily. If the case is uncrowded, or there is only mild crowding, all the anterior teeth can be bracketed at the start. The mechanics are normally easy, as shown in Figs. 10.03 & 10.04.

However, if there are 'blocked out' or very crowded teeth, they should not be bracketed at the outset, as shown on the next two pages (Figs. 10.10 series). This treatment method means that in some cases one or more incisors, and occasionally a second premolar, will be left out of the set up at the start. This allows earlier use of round stainless steel wires, up to .020 in size, which in turn reduces tipping of canines and posterior teeth. It also moves the case towards the planned arch form.

Anchorage from lacebacks

It has been said that during levelling and aligning, lacebacks are used to control the canines and bendbacks to control the incisors. This is true.

Lacebacks are an essential part of the technique (Fig. 10.07). They control the canines, and have been used and recommended by the authors since 1989 [6]. They prevent any mesial movement of canine crowns early in treatment, which might occur due to the tip in the canine bracket, and encourage bodily distal movement as alignment progresses. This in turn provides space to align the anterior teeth.

Lacebacks are used mainly in premolar extraction cases. It may be that they cause an immediate slight tipping of the canines and posterior teeth, with some compression of the periodontal space (Fig. 10.08). This is followed by a reduction in force, which allows the heavier round stainless steel wires to upright the roots. Additionally, there may be a 'trampoline effect' during mastication, which adds to their effectiveness (Fig. 10.09).

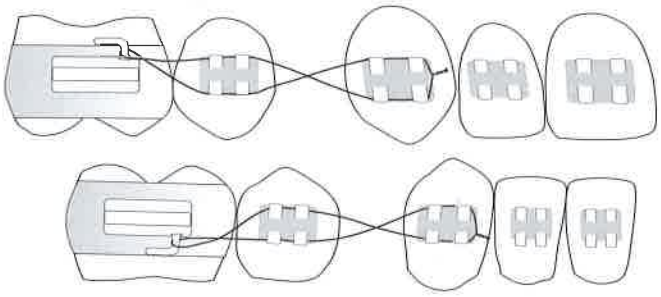

Fig. 10.07 Lacebacks control the canines, and prevent any mesial movement of canine crowns early in treatment. Later, they encourage bodily distal movement as alignment progresses, which provides space to align the anterior teeth.

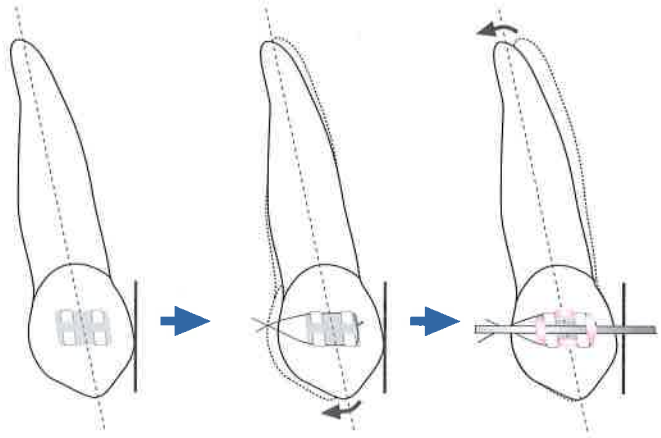

Fig. 10.08 It may be that there is an immediate slight tipping of the canines and posterior teeth with lacebacks, and some compression of the periodontal space, as suggested in this drawing, based on the original diagram from 1989. This may be followed by a reduction in force, and the round stainless steel wire uprighting the roots.

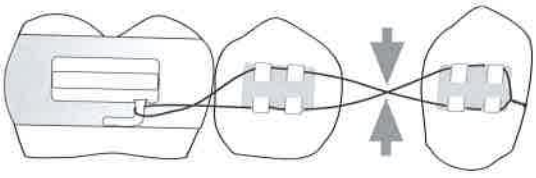

Fig. 10.09 There may be a 'trampoline effect' during mastication, along with the effect in diagram 10.08 above, which may increase the effectiveness of lacebacks.

Two stage levelling and aligning in cases with moderate or severe anterior crowding

If there is moderate or severe crowding in a first premolar extraction case, or if there are individual teeth which are a long way from the main arch form, the authors sometimes consider a two-stage approach to levelling and aligning. This approach is shown in the series of drawings Fig. 10.10 and in case RO later in this chapter (page 200).

First stage
(Figs. 10.10 A, B & C) During the first stage it is normally effective to align the teeth, within the arch form, to a steel .018 or .020 round wire. Poorly aligned teeth, that are out of the main arch form, are not bracketed at this time, and where necessary lacebacks and/or coil springs are used to provide space for these teeth (Fig. 10.10 B & C). Tubing can be used to support any longer spans of light wire, where needed. The aim is to create space for teeth which are a long way from the main arch form, while maintaining anchorage control. It is an advantage that arch form can be maintained by using this two stage approach in selected cases.

Second stage
(Figs. 10.10 D, E & F) For the second stage, it is necessary to bond brackets on to any badly aligned tooth or teeth, plus any newly erupted teeth, and go back to a light wire such as .016 HANT to 'pick them up' (Fig. 10.10 D). The case can be managed as a routine treatment from this point on. Lace backs (not drawn) and bendbacks are used for anchorage control and to support the light wires early in treatment. Steel round wires will be needed if there is a steep curve of Spee.

After the case has reached . 019 / .025 rectangular steel working wires, sliding mechanics are used to meet the requirements of the case (Fig. 10.10 E). Reciprocal space closure was used in the diagrammatic case represented here, and the lower incisors moved only a small amount distally, relative to APo line.

In a Class III case, or if there is bimaxillary protrusion, anchorage support could be increased to produce more anterior retraction, using the methods discussed in chapter eight (page 114).

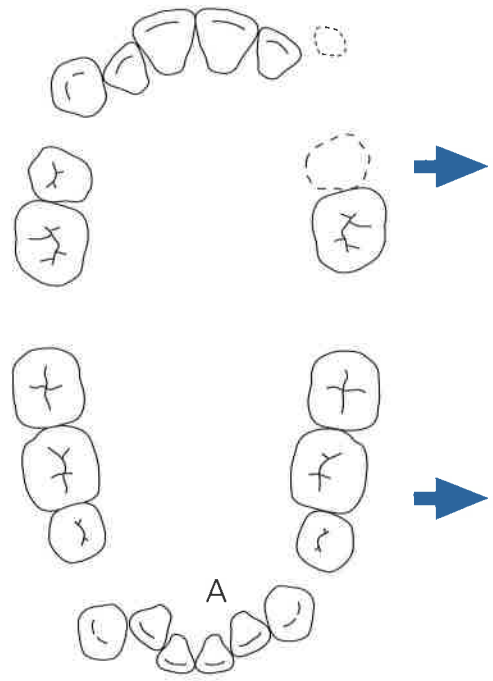

Fig. 10.10 A.

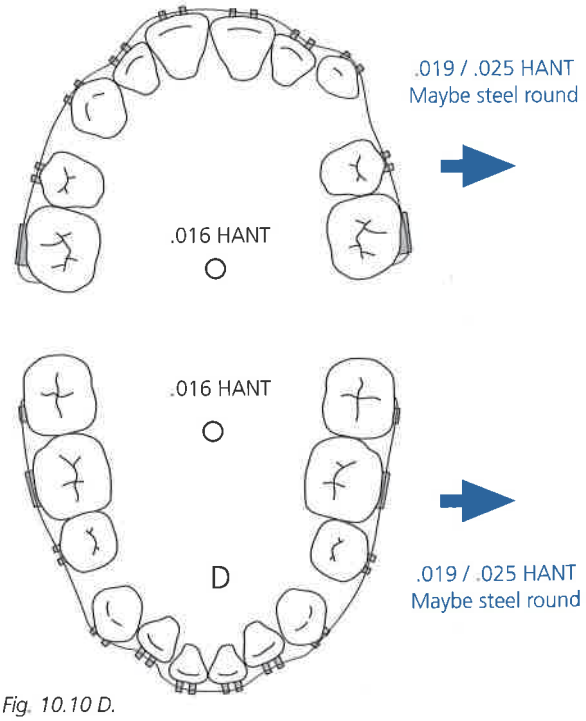

Fig. 10.10 D.

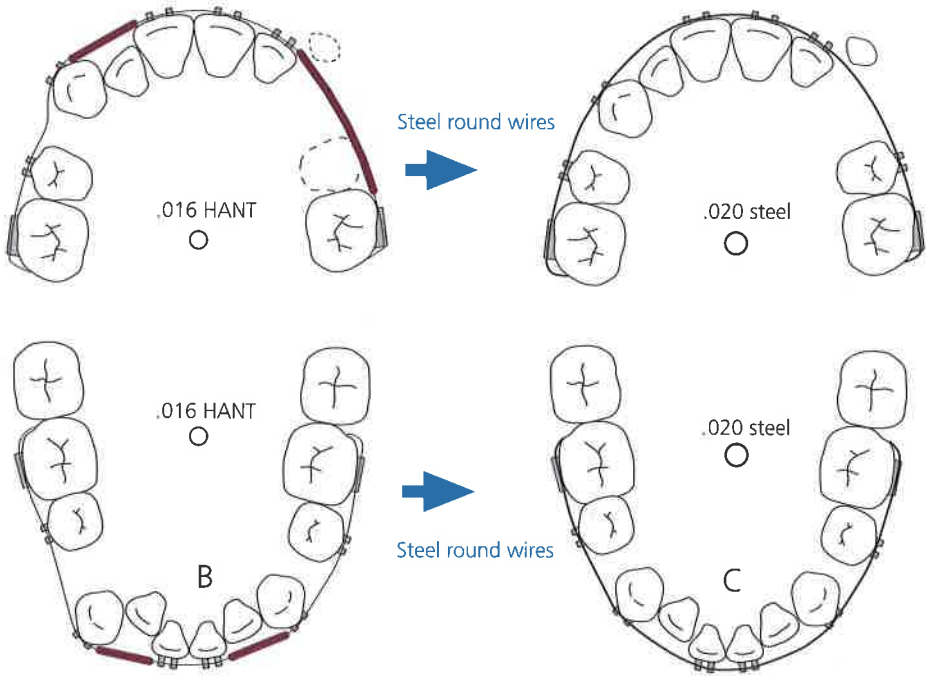

Fig. 10.10 B & C.

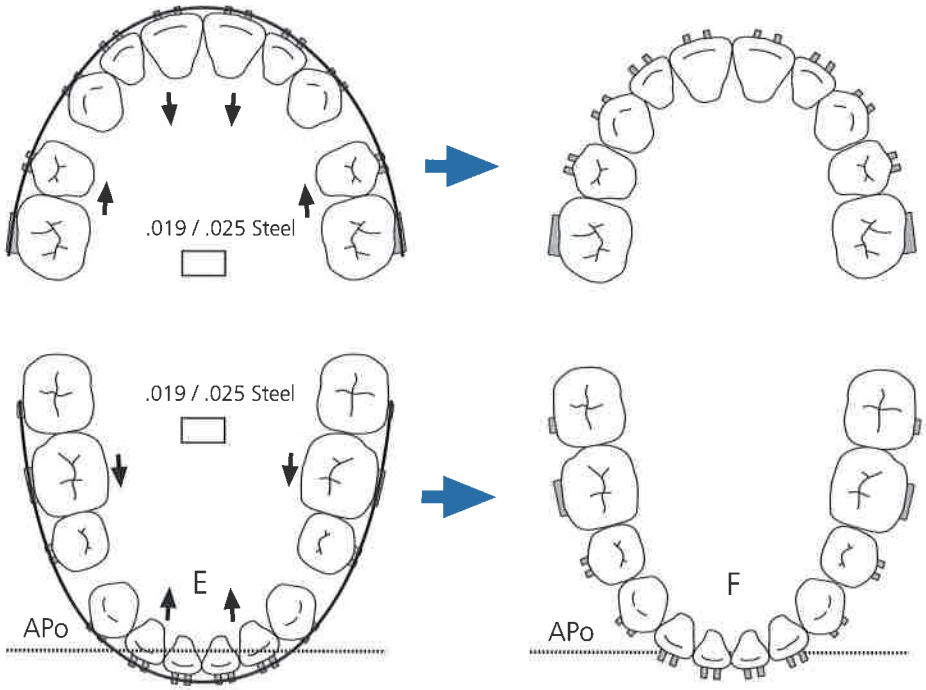

Fig. 10.10 E & F.

The purpose of bendbacks

Bendbacks are also an essential part of the technique. They control arch length, and are used in almost all cases during levelling and aligning. They are not used with steel rectangular wires in normal full arch mechanics, because arch length is controlled with tiebacks (page 107). It is recommended that bendbacks are not attempted with steel rectangular wires, as they make arch removal impossible without a risk of bond failure of tubes.

For good bendbacks, about 4 mm of each end of the wires needs to be heated to bright orange or red with a flame and then quenched before placement. If levelling and aligning wires are softened in this way, the bendbacks can be accurate. Also, the wire can be easily and comfortably removed at the check-up, with less risk of breaking a bonded molar tube.

Bendbacks (B3 p. 102) make the wire comfortable for the patient. They also play an important part in anchorage, by limiting arch length and thereby restricting mesial movement of incisors (Fig. 10.11). Consequently, they are made a little distal to the molar tubes in cases where there may be a need to increase arch length during levelling and aligning, such as some Class II/2 malocclusions (B3 p.171).

A bendback is created by turning the end of the wire either towards the gingiva, or towards the interstitial space. Orthodontists have their preferred methods for doing this, and a tucking instrument can be used instead of pliers.

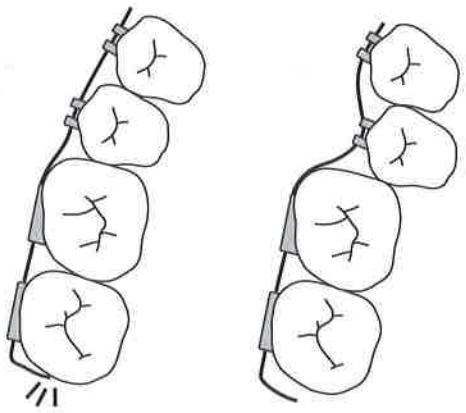

Fig. 10.11 The routine bendback is against the distal of the molar, to restrict arch length and incisor proclination. If there is a need to increase arch length, as in most Class II/2 non-extraction treatments for example, the bendback is made a little distal to the molar.

The inclusion of second molars

In the lower arch, after canines have been retracted sufficiently to provide adequate space for incisor alignment, brackets and tubes can be placed on the remaining lower teeth. This normally includes lower second molars in average to low angle cases, because arch levelling and overbite control is better when these teeth are included. Levelling and aligning of the arches becomes more efficient and routine after brackets and tubes are placed on additional teeth, and first premolar extraction cases move ahead much like non-extraction cases. In high angle cases, the second molars are usually not included at this stage, because the arch levelling needed for sliding mechanics tends to open the bite. After lower arch levelling and space closure in these high angle cases, second molars can be included, with curve left in the posterior aspect of the arch wire.

In the upper arch, an attempt to maintain a Class I canine relationship is beneficial, as the contact of the lower canines against the upper canines helps in upper canine retraction. In this situation, due to the overjet, there may be minor spacing in the upper incisor area which will allow upper incisor bracketing to occur earlier. The remaining upper and lower teeth can be bracketed at this time. The upper incisors may need to be held together as a group with a light elastic chain or a 'figure eight' ligature, to avoid patient concerns about spacing, which can appear.

If excessive bite opening is a concern, bonding tubes on to upper second molars at this time should be avoided. After space closure, upper second molars can be included. To avoid extrusion, the tubes can be bonded more occlusally, with stepping up of the arch wire if needed (Fig. 10.12).

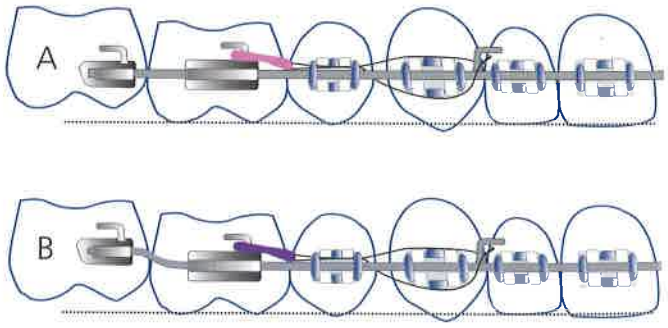

Fig. 10.12 If there are anterior open bite concerns, bonding of upper second molars can be delayed until after space closure, or the tubes can be bonded more occlusally (A). Stepping up of the archwire (B) will prevent molar extrusion, but it is a less suitable option, as it requires the wire to be placed in a convertible molar tube.

Archwires mesial to lower second molars

At the start of treatment a light wire such as .016 HANT is normally used. If it is essential to include the lower second molars at this stage, it is helpful to extend the laceback to the second molar tube (Fig. 10.13). It will provide some support for a light wire in the vulnerable area mesial to the lower second molar.

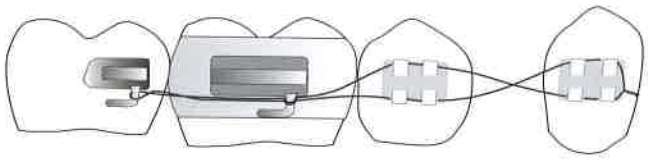

Fig. 10.13 If it is essential to include the lower second molars at the start of treatment, it is helpful to extend the laceback to the second molar tube.

Light wires are susceptible to distortion by biting forces between the lower first and second molars, particularly when the patient is new to orthodontics and inexperienced in appliance care. Distortion of .016 HANT can lead to sharp wire ends and patient discomfort, with extra visits to the practice. If light steel wires of .014 and even .016 distort in this area, it can cause problematical mesial tipping of the second molar (Fig. 10.14). For these reasons, many orthodontists prefer to delay including lower second molars until the alignment of the anterior teeth is progressing well, and the patient is experienced in appliance care. A HANT wire such as .017 / .025 or .019 / .025 can normally be placed, which is effective in this area and does not distort in the same way as the lighter wires.

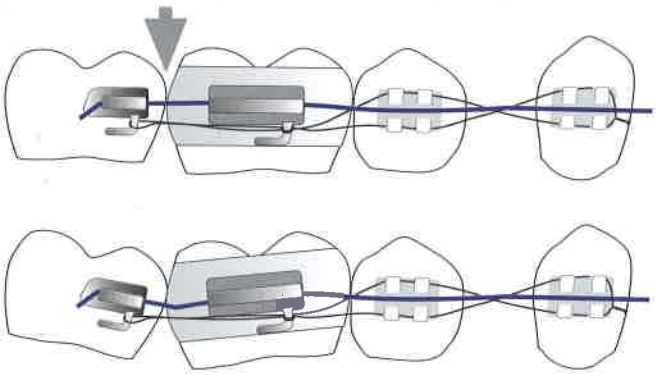

Fig. 10.14 light steel wires of .014 and even .016 can distort in the second molar area, which will cause problematic mesial tipping of the molars.

Overbite control

With first premolar extraction cases, the first few visits are not always focused on achieving anterior alignment. In some cases, the main aim will be the bodily retraction of canines. Also, special attention is not given to overbite. However, if there are concerns that lower brackets are in contact with the upper dentition during these early stages, then the use of bite opening devices such as bite plates or 'turbos' can be considered, to manage any interferences. At the stage when all teeth have been bonded with brackets or tubes, bite opening can progress in an efficient manner. The case can be managed in the same way as a non-extraction treatment, and the overbite control techniques discussed in chapter nine can be used, including minor bite opening curves. As with any orthodontic treatment, if there is a deep curve of Spee in the lower arch, it is important to include lower second molars for full and efficient correction.

Progress review of the case

In many cases it is convenient to have a 'Progress Review' (page 146) after completing overbite correction. In premolar extraction cases this is often done later in treatment, as in case RO at the end of this chapter (page 200).

Space closure with the SWA

With the edgewise appliance, sliding mechanics were seldom attempted for space closure, because the molar offsets and omega loop tiebacks prevented free sliding. Instead, closing loop mechanics were used for space closure. When the Straight Wire Appliance (SWA) was developed by Andrews, many orthodontists continued to use closing loops which generate up to 600 gm of force when activated. Others began attempting sliding mechanics with the same heavy forces in the 600 gm range, using springs and other methods to close spaces.

With time, many clinicians using closing loop mechanics began using different loop designs to reduce forces. For example, Dr. Ron Roth recommended double T loops to reduce forces. This gave greater wire flexibility in the extraction areas, but required the use of gable bends in some cases. Those orthodontists using sliding mechanics found that lighter forces produced more effective sliding of the arch wire, because there was less wire deflection and hyalinization of the adjacent tissues. Elastic chains became widely used for space closure, applying up to 400 gm of force. However, these experience a 'decay' process [7] to approximately half their force level within 24 hours.

Routine space closure with sliding mechanics

The following method of space closure has been developed and refined over three decades. It uses light continuous forces, group movement, and sliding mechanics, and is recommended by the authors. It can be easily and reliably delegated to assistants.

When .019 / .025 wires are placed for the first time, passive wire tiebacks of .010 ligature wire are used for about a month (Fig. 10.15). During this time the torque expression occurs and levelling of the arches is completed. Both of these effects lead to improved sliding mechanics (B3 p. 254). Passive wire tiebacks are also used to hold spaces closed at the end of space closure (Fig. 10.16).

After about four weeks with passive tiebacks, active tiebacks are placed for space closure (Figs. 10.17 A & B) and sliding mechanics can begin. The modules in the active tiebacks are stretched to a maximum of twice their normal length. It is important not to overstretch them. Depending on the type of module used, this generates up to 200 gm of force, and these light forces are particularly effective when large extraction spaces need to be closed, because deflection in those critical areas is minimal. The appliance should be checked every four to six weeks during space closure, and active tiebacks can be reactivated or replaced with new ones at each adjustment visit. If patient cooperation with care and oral hygiene is good, adjustments need be every six weeks at this stage.

The ends of the wire should protrude by 0.5 mm or 1.0 mm from the distal of the molar tube when the patient leaves after the adjustment visit. They should not end in the molar tubes. If the wire ends in the molar tube, there may be no sliding mechanics in that quadrant, because there is the risk that the molar will rotate and the wire will jam in the tube. The cut end of the wire should be smoothed, to avoid soft tissue trauma as wire emerges distally during tooth movement.

Active tiebacks are preferable to elastomeric chain, which is not recommended for routine space closure, except for final minor spaces of 1.0 mm or less (page 237). Chain can also be used to hold spaces closed.

Space normally closes at 1.0 mm – 1.5 mm per visit. Progress can be checked by measuring the spaces or by observing the amount of wire protruding from the molar tubes when the patient attends for an adjustment.

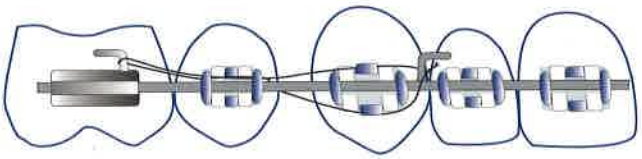

Fig. 10.15 After placement of .019 / .025 working steel wires, passive tiebacks are used for one month, while torque settles and levelling is completed. They are also used to hold spaces closed at the end of space closure (see Fig. 10.16). Here they are stabilized by modules on the second premolars.

Fig. 10.16 Here passive tiebacks are being used to prevent spaces from opening after space closure.

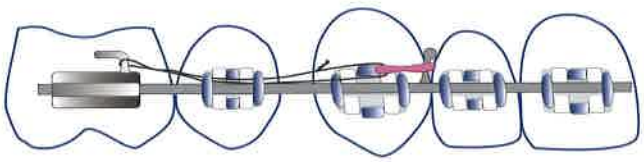

Fig. 10.17 Part A. An active tieback, with the module placed at the mesial, stabilized by a module on the second premolar. The ends of the wire should protrude a little from the molar tube.

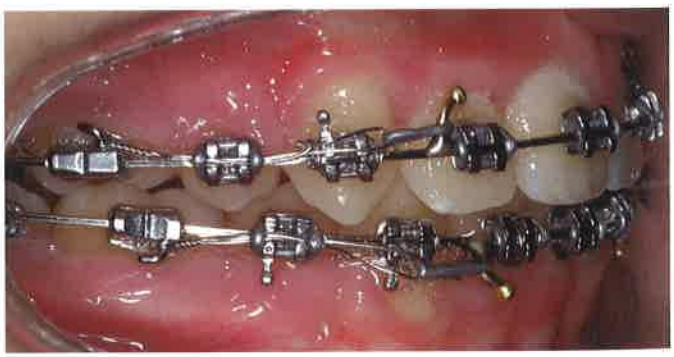

Fig. 10.17 Part B. Active tiebacks during final space closure.

Class II elastics during space closure

During routine space closure in a Class I case there is a tendency for upper space to close more easily than lower space. If needed, the patient can be asked to wear light Class II elastics at night, to maintain a molar relationship.

Alternative methods of space closure

Most cases respond well to active tiebacks, and show the desired 1 mm per month of space closure. Possible obstacles to this have been previously discussed (B3 p. 259) and they include inadequate levelling, damaged brackets, incorrect force levels, interference from opposing teeth and gingival overgrowth. These possibilities should be checked before considering alternative methods of space closure.

It is a mistake to increase force levels in an attempt to accelerate space closure to a rate which is faster than 1.0 mm to 1.5 mm per month, because unwanted tooth movements will occur (B3 p. 253). The rate of space closure is limited by cell metabolism, and there is variation between individuals. Active tiebacks are effective in almost all cases. The mechanics can be changed, as described below, but it is seldom necessary.

Increasing the elastic force on an active tieback
It is possible to replace the single elastomeric module with two modules, or with a separating elastic. This increases the force and can sometimes be helpful when there is a small amount of remaining extraction space to close.

Bending a closing loop
If there is a difficult space in an adult case, closing loops can be placed in a rectangular wire (B3 p. 252), and made active by tying back to an omega loop (Fig. 10.19). This has only a small range of action, but it is usually enough to solve the problem.

The Hycon™ device
This requires patient activation, but is a sure way of dealing with space closure problems in adult cases (B3 p.268). The latest version is described on the next page.

Elastic chains
Towards the end of space closure, when only minor spaces are remaining and inter-bracket distances are small, elastic chains can be helpful (Fig. 10.20). These apply up to 400 gm when placed, but this rapidly reduces over the first 24 hours. They are effective at 'cinching up' any small spaces, and keeping them closed. Light chains are routinely used in the weeks before appliance removal, as described in chapters 12 & 13.

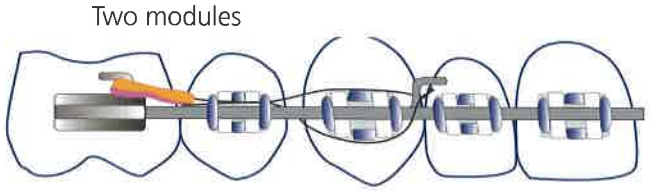

Fig. 10.18 Using two modules or a separating elastic increases the force of a conventional active tieback. This can sometimes be helpful if there is a small amount of remaining extraction space to close.

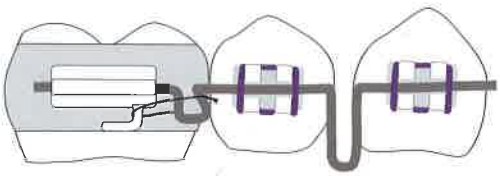

Fig. 10.19 Loops are not recommended for routine space closure. If there is a small residual space in an adult case, a closing loop can be bent into a rectangular wire, and made active by tying back to an omega loop. There is only a small range of action, but usually enough to solve the problem. It is possible to use closing loops without the omega loop, and bend down the wire distal to the molar tube for activation. However, after this it is not possible to remove the archwire for adjustment.

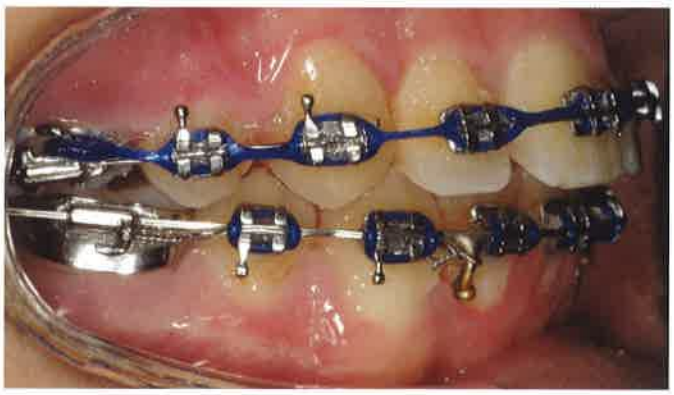

Fig. 10.20 Chains are not recommended for routinely closing spaces. Towards the end of space closure, if only minor spaces remain and inter-bracket distances are small, elastic chains are sometimes helpful. They are effective at 'cinching up' any small spaces, and then keeping them closed.

Space closure with the Hycon™ device

It is accepted that space closure is often more difficult in adult patients, due to various factors. For example, the bone is mature and may be narrowed in the extraction sites, and heavy occlusion can hold teeth in position, preventing them from moving. Sometimes in these cases most of the extraction site can be closed by conventional active tiebacks, but a small space remains, which is resistant to final space closure. There are several options to deal with this, but the Hycon™ device [8] is an effective and well tried method.

The Hycon was invented by Dr. Winfried Schütz, a German orthodontist, and the authors have previously published a case showing its use (B3 p. 264). The original soldered type has been replaced by a newer and better version, with a clip-on mechanism which avoids the need for auxiliary tubes (Figs. 10.21 and 10.22). The mechanism clips to the arch wire between the first and second molars, and functions much like a sliding hook. It is tied anteriorly to the hook on the archwire.

One full turn of the screw (369°) represents the pitch of the screw. The distance of this activation is 0.350 mm, and generates up to 410 gm, as measured on an Instron machine. In clinical use, the screw is turned until the slack in the ligature wire is taken out, as with a laceback. This is followed by one half turn per week. This is done by the patient, and provides 0.175 mm of activation, and a force of about 200 gm. Normally the aim is for approximately 12 turns over a six week period. It is also beneficial to tie the first and second molars together to prevent spaces from opening between these teeth.

Patient cooperation is essential for this method of space closure. However, when used properly, it is very effective in closure of persistent spaces, which do not respond to normal mechanics [8].

Fig. 10.21 The newest version of the Hycon™ device (the Hycon II) has a clip on mechanism. This avoids the need for auxiliary tubes on the molars. The Hycon II attaches to the arch wire between the first and second molars, much like a sliding hook. It is tied anteriorly, normally to the arch wire hooks.

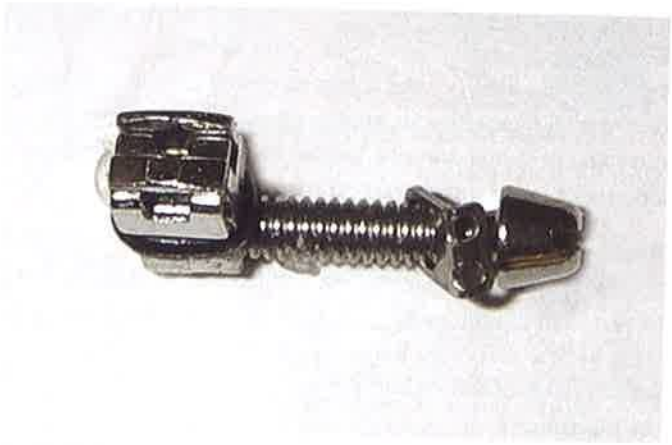

Fig. 10.22 The Hycon II

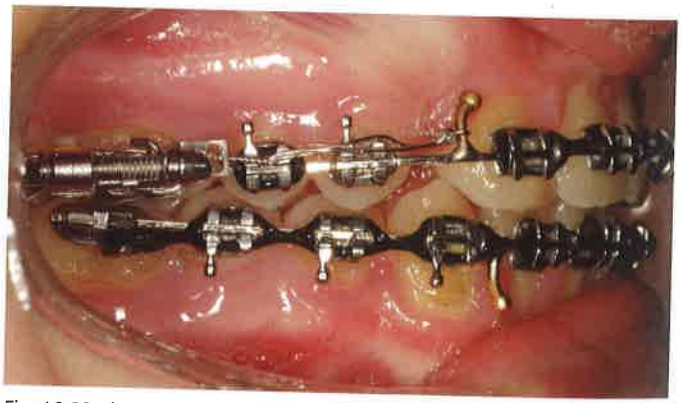

Fig. 10.23 The Hycon device, when used properly, is very effective in closure of persistent spaces, which do not respond to normal mechanics

Arch wire sequencing (one stage)

All malocclusions are different, but general comments are helpful concerning the archwires used. In first premolar extraction cases the sequencing depends on the anterior crowding, as described in a series of diagrams earlier in this chapter (Figs. 10.03, 10.04 and 10.10).

For uncrowded or mildly crowded cases (Figs. 10.24 A, B & C) with no instanding or 'blocked out' teeth, the following sequence is normally used:

- Light .016 HANT wires are used to start alignment of the anterior teeth, and may be in place for one or more months. These are gentle wires and help the patient to adjust to the appliances.
- After the .016 HANT wires, the case can move to rectangular .0195 / .025 HANT, normally for one or two months.
- Working .019 / .025 stainless steel wires are then placed to complete levelling, torque control and final space closure.
- Light settling wires are used briefly before appliance removal, and the various options for settling are discussed in chapter 12.

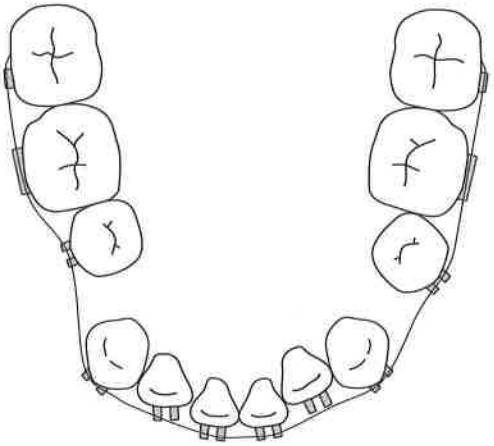

Fig. 10.24 Part A. In the above case the opening wire can be loosely tied on to brackets of teeth which are out of alignment, with more or complete engagement into the bracket slot after a month. The wire sequence could be:

- *.016 HANT + lacebacks & bendbacks (2 or 3 months)*
- *.019 / .025 HANT + lacebacks & bendbacks (2 months)*
- *.019 / .025 steel + passive tiebacks (1 month)*
- *.019 / .025 steel + active tiebacks (8 months)*
- *.019 / .025 steel + passive tiebacks (3 months)*
- *.014 steel + lacebacks & bendbacks (a few weeks)*

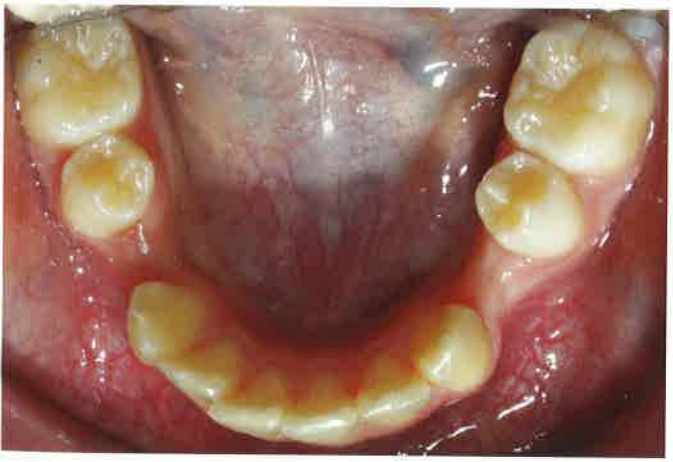

Fig. 10.24 B. First premolars were extracted before referral in this mildly crowded lower arch, with slight bimaxillary protrusion. There has been some narrowing of the bone on the left side, and canines and second premolars are rotated a little towards the extraction sites. One stage levelling and aligning is normally possible for uncrowded or mildly crowded cases like this.

Fig. 10.24 C. In a mildly crowded case the opening wire can be fully engaged with gentle modules, as seen here, or loosely tied on to the brackets of teeth which are out of alignment. More or complete engagement into the bracket slots is possible after a month, as the case unravels. Lacebacks are continued until good incisor alignment has been achieved.

Arch wire sequencing (two stage)

For cases which have anterior crowding and/or instanding or 'blocked out' teeth (Figs. 10.25 A, B & C) the following sequence is recommended:

- Opening .016 HANT wires are used to start alignment of those anterior teeth which are bracketed, and are in place for about one month. These are light wires and help the patient to adjust to the appliances.
- The case then goes through a series of stainless steel round wires, selected from the sizes .014, .016, .018, and .020. Not all these sizes will be used, and the aim in this early stage of treatment is to reach a .018 or .020 round wire, and to use lacebacks to guide the canines distally towards the extraction sites, with minimal tipping.
- When there is enough anterior space, brackets are placed on the remaining teeth, and the case goes to .016 HANT wires again.
- The normal .019 / .025 HANT wires are used after the .016 HANT wires.
- Steel .019 / .025 wires are needed to complete levelling, torque control and final space closure.
- Finally, light wires are used to settle the case, as necessary (Chapter 12).

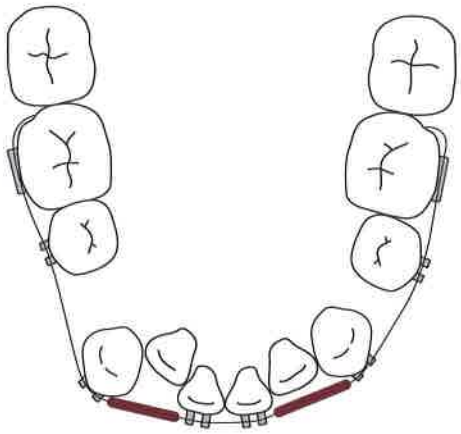

Fig. 10.25 Part A. In this case the wire sequence might be:

- *.016 HANT + lacebacks & bendbacks (1 month)*
- *.016 steel + lacebacks & bendbacks (1 month)*
- *.020 steel + lacebacks, coils & bendbacks (3 months)*
- *---------- Brackets bonded to the remaining teeth ----------*
- *.016 HANT + lacebacks & bendbacks (3 or 4 months)*
- *.019 / .025 HANT + lacebacks & bendbacks (2 months)*
- *.019 / .025 steel + passive tiebacks (1 month)*
- *.019 / .025 steel + active tiebacks (6 months)*
- *.019 / .025 steel + passive tiebacks (3 months)*
- *.014 steel + lacebacks & bendbacks (a few weeks)*

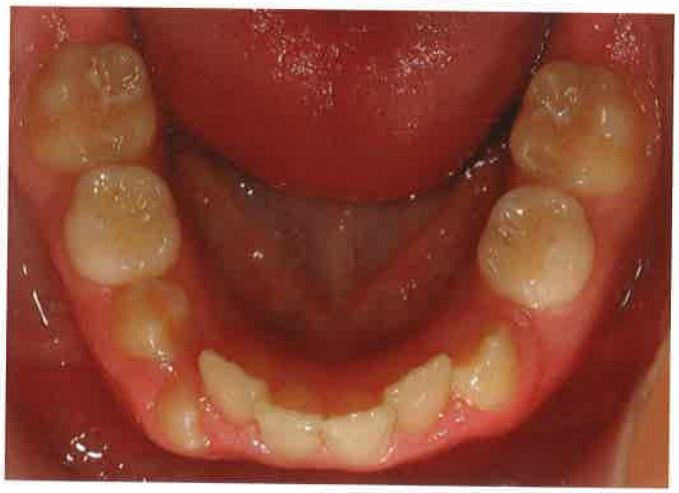

Fig. 10.25 B. Two stage levelling and aligning should be considered for cases which have anterior crowding and/or instanding or 'blocked out' teeth. Individual teeth which are a long way from the main arch form are included later.

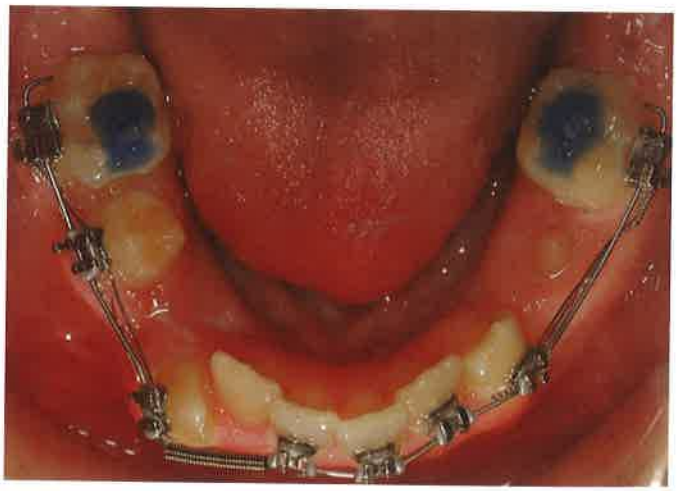

Fig. 10.25 C. Initial .016 HANT wires are used to start alignment of those anterior teeth which are bracketed. Lacebacks guide the canines into good position, and arch form can be maintained.
(Case RO page 200).

PREVIOUS BOOKS

B1 Bennett J, McLaughlin R P. 1993 Orthodontic treatment mechanics and the preadjusted appliance. Mosby-Wolfe, London ISBN 0 7235 1906X

B2 Bennett J, McLaughlin R P. 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford ISBN 1 899066 91 8. Republished in 2002 by Mosby, Edinburgh ISBN 07234 32651

B3 McLaughlin RP, Bennett JC, Trevisi HJ. 2001 Systemized orthodontic treatment mechanics. Mosby International ISBN 072343171X

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2. Case CS. The question of extraction in orthodontia. (Reprint) Am J Orthod 1964; 50: 658-91.

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4. Begg PR. Stone age man's dentition with reference to anatomically correct occlusion, the etiology of malocclusion and a technique for its treatment. Am J Orthod 1954; 40: 298-312 and 462-75.

5. Roth R. 1970 Gnathologic concepts and orthodontic treatment goals. In: Jarabak JR, ed. Technique and treatment with light wire appliances. St. Louis: C.V. Mosby, pp. 1160-223.

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8. McLaughlin RP, Kalha AS, Scheutz W. An alternative method of space closure: the Hycon device J. Clin Orth. 2005 474 – 484

Case report RO

A 12.6 year male patient with a Class II skeletal and facial pattern. There was moderate crowding in the lower arch and severe crowding in the upper arch. The panoramic radiograph (Fig. 10.36) showed a healthy dentition, with generalized crowding of anterior and posterior teeth, and the presence of well formed third molars.

R.O.
BEGINNING
12.6 yrs

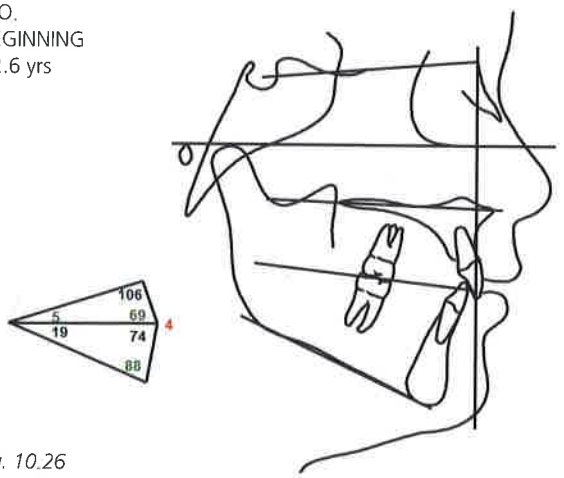


Fig. 10.26

SNA 85°
SNB 80°
ANB 5°
A-N ⊥ FH 0 mm
Po-N ⊥ FH -10 mm
WITS 4 mm
GoGn SN 27°
FM 25°
MM 23°
↑1 to APo 4 mm
↓1 to APo 0 mm
↑1 to Max Plane 106°
↓1 to Mand Plane 88°

R.O.
BEGINNING
12.6 yrs

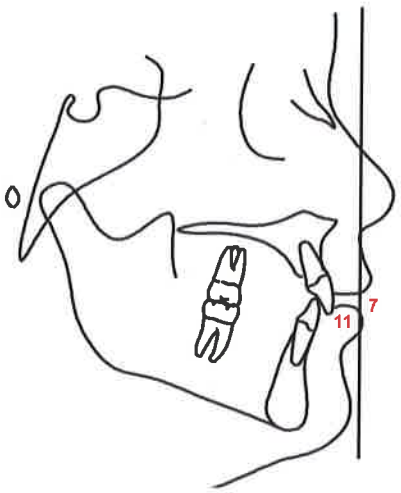


Fig. 10.27

↑ Incisor torque to occl. plane 65°
↑ Incisor tip to TVL -10 mm
↑ Lip thickness 14 mm
↑ Lip to TVL 4 mm

Max. anterior height 26 mm
↑ Lip length 20 mm
↑ Incisor exposure 7 mm
Inter-labial gap 4 mm

Occlusal plane to TVL 95°
↓ Incisor torque to occl. plane 68°
↓ Lip thickness 11 mm
↓ Lip to TVL 1 mm
Soft tissue 'B' point -6 mm
Soft tissue pogonion -3 mm

Cephalometrically (Figs. 10.26 & 10.27) the patient showed a slight Class II skeletal pattern, an average vertical pattern, and upright upper and lower incisors. In the upper anterior segment, the incisors and lip thickness were normal. The incisor exposure was 6 mm. The lower anterior segment was a little retrusive and the occlusal plane angle was slightly steep.

Fig. 10.28

Fig. 10.29

Fig. 10.30

Fig. 10.31

Fig. 10.32

Fig. 10.33

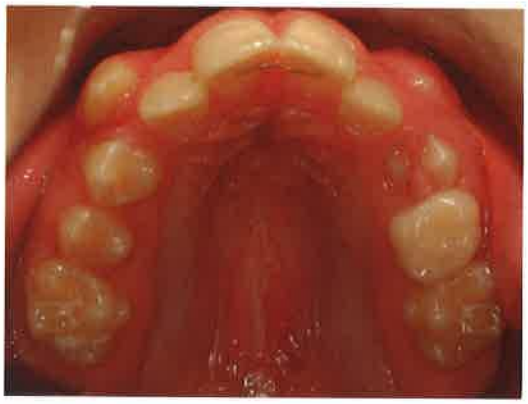


Fig. 10.34

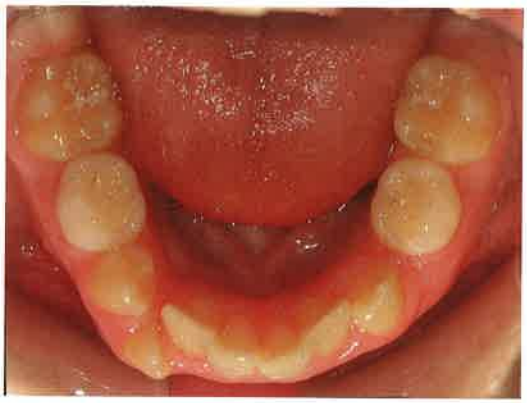


Fig. 10.35

Fig. 10.36

First stage

All first premolars were extracted along with the lower left second primary molar. The case was discussed with the family, and they were eager to start treatment. Accordingly, brackets were placed on the erupted permanent teeth, except for the lingually blocked out lower right lateral incisor (Figs. 10.37 to 10.42).

'Turbos' were bonded on to the lower first molars to temporarily open the bite. Turbos are difficult to remove if placed in this area, and in most cases are more efficient when placed on the mesio-palatal cusp of the upper first molars. Lacebacks were placed from first molars to brackets on the three erupted canines for canine management and retraction. The aim was to guide the canines into the extraction sites with minimal tipping. The normal .016 HANT wires were placed in both arches. Bendbacks were used distal to the first molars to minimize incisor flaring. Light closed coil springs were placed where spaces occurred for comfort purposes and to stabilize the arch wires.

The case is seen two months later (Figs. 10.43 to 10.45). At this visit lacebacks were tightened on the three bracketed canines, sufficiently to take up the slack. Stainless steel .016 round wires were placed, along with a passive closed coil spring between the lower right central incisor and the lower right canine. Bendbacks were continued distal to the first molars.

The case progressed to stainless steel .020 round wires (Figs. 10.46 to 10.48) with a light open coil spring for the lower right lateral incisor. This tooth moved labially in response to tongue pressure, as space was made in the area. Lacebacks were continued for the canines with bendbacks distal to the first molars.

Brackets were bonded on to the left second premolars and the upper left canine. Inclusion of these teeth at this stage was helpful for arch stabilization. The brackets were not placed gingivally enough (Fig. 10.48) due to partial eruption, and would be repositioned later. The correct position can be seen in Fig. 10.75 (page 209).

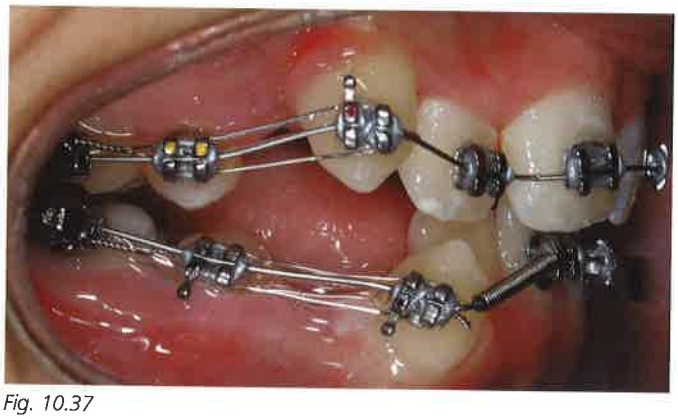


Fig. 10.37

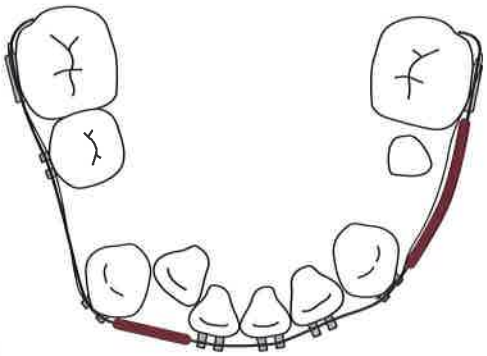


Fig. 10.40

Fig. 10.43

Fig. 10.46

Fig. 10.38

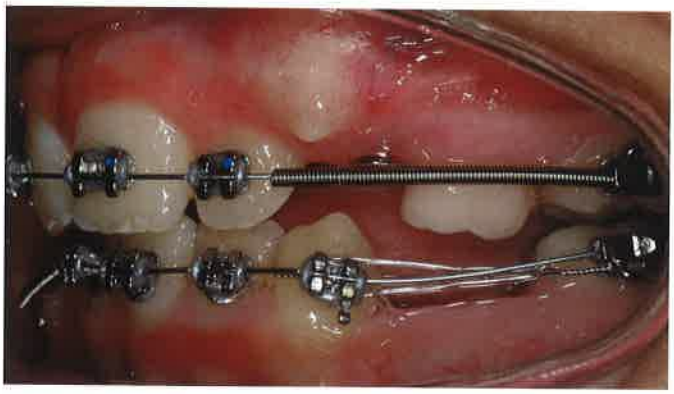


Fig. 10.39

Fig. 10.41

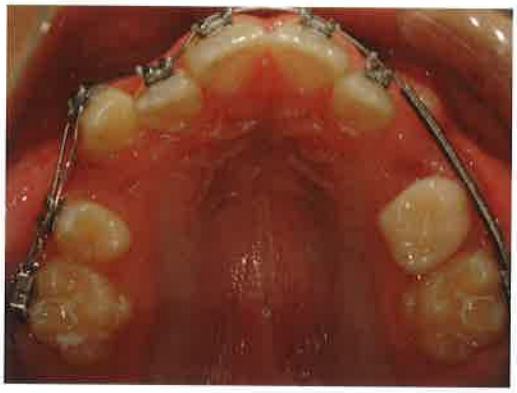


Fig. 10.42

Fig. 10.44

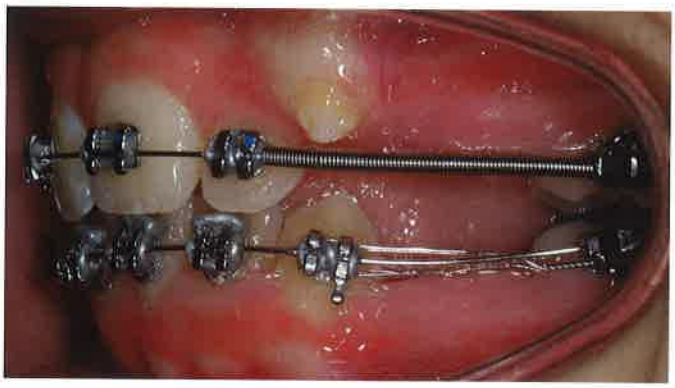


Fig. 10.45

Fig. 10.47

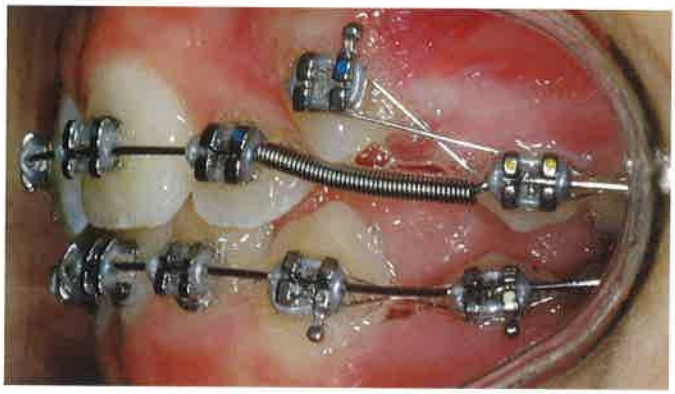


Fig. 10.48

First stage

All first premolars were extracted along with the lower left second primary molar. The case was discussed with the family, and they were eager to start treatment. Accordingly, brackets were placed on the erupted permanent teeth, except for the lingually blocked out lower right lateral incisor (Figs. 10.37 to 10.42).

'Turbos' were bonded on to the lower first molars to temporarily open the bite. Turbos are difficult to remove if placed in this area, and in most cases are more efficient when placed on the mesio-palatal cusp of the upper first molars. Lacebacks were placed from first molars to brackets on the three erupted canines for canine management and retraction. The aim was to guide the canines into the extraction sites with minimal tipping. The normal .016 HANT wires were placed in both arches. Bendbacks were used distal to the first molars to minimize incisor flaring. Light closed coil springs were placed where spaces occurred for comfort purposes and to stabilize the arch wires.

The case is seen two months later (Figs. 10.43 to 10.45). At this visit lacebacks were tightened on the three bracketed canines, sufficiently to take up the slack. Stainless steel .016 round wires were placed, along with a passive closed coil spring between the lower right central incisor and the lower right canine. Bendbacks were continued distal to the first molars.

The case progressed to stainless steel .020 round wires (Figs. 10.46 to 10.48) with a light open coil spring for the lower right lateral incisor. This tooth moved labially in response to tongue pressure, as space was made in the area. Lacebacks were continued for the canines with bendbacks distal to the first molars.

Brackets were bonded on to the left second premolars and the upper left canine. Inclusion of these teeth at this stage was helpful for arch stabilization. The brackets were not placed gingivally enough (Fig. 10.48) due to partial eruption, and would be repositioned later. The correct position can be seen in Fig. 10.75 (page 209).

Fig. 10.37

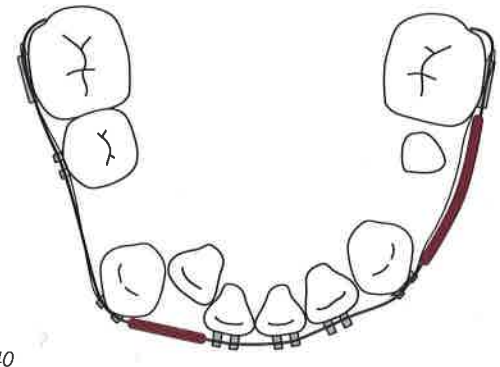


Fig. 10.40

Fig. 10.43

Fig. 10.46

Second stage

Levelling and aligning.
Lacebacks were continued in all four quadrants (Figs. 10.49 to 10.51). An upper .016 HANT arch wire was placed, to include the upper left canine, which had moved distally and occlusally. In the lower arch, the .020 round wire was continued for canine control, and the open coil spring for the lower right lateral incisor was gently re-activated. Bendbacks were continued distal to the first molars. Now that bracketing has been completed, except the unerupted second molars, conventional mechanics can be used, and levelling and aligning can proceed more efficiently.

Fig. 10.49

The lower right lateral incisor was bracketed. Lacebacks were continued, and .019/.025 HANT wires were placed. The canines had been maintained in a Class I position, and as a result, space had been opened in the upper anterior area (Figs. 10.52 to 10.54). It is recommended to use 'Figure 8' ligature wires or light elastic chains in the upper incisor area to avoid patient complaints of anterior spacing. Levelling and aligning had been completed, except for the erupting second molars. The crossing over of modules, seen on canines and premolars in Figs 10.52 and 10.54, is not normally recommended by the authors.

Fig. 10.52

Overbite control.
Including the lower second molars helps in levelling the curve of Spee and opening the bite. Accordingly, mini tubes were bonded on to the mesial cusps of the lower second molars, and a lower .019/.025 HANT arch wire was placed (Figs. 10.55 to 10.60). It was possible to place mini tubes on the lower second molars, even though soft tissue still covered the distal of these teeth. Using mini tubes in this way (B3 p.54) allows early inclusion of lower second molars, so there is no delay in the correction of deep bites, while awaiting full eruption of the molars. There are 'Figure 8' ligatures from lower molar tubes to canine brackets to prevent extraction spaces from opening.

Fig. 10.55

A steel .019 / .025 working wire is in place, with active tiebacks, at the start of space closure. The activation shown is the maximum for optimal mechanics. The modules are normally stretched a little less than depicted in Figs. 10.55 and 10.57. A light elastomeric chain is used among the upper incisors to close minor anterior spacing.

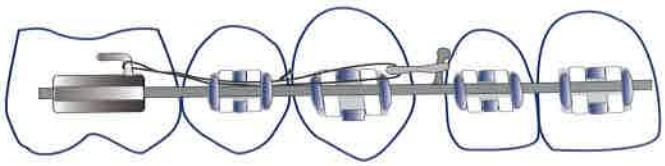


Fig. 10.58

Fig. 10.50

Fig. 10.51

Fig. 10.53

Fig. 10.54

Fig. 10.56

Fig. 10.57

Fig. 10.59

Fig 10.60

Space closure.
Good bite opening had been achieved, and conventional space closure mechanics can be seen. Upper and lower .019 / .025 steel arch wires are in place, with soldered hooks between lateral incisors and canines (Figs. 10.61 to 10.66). Active tiebacks were used in all four quadrants to close the small remaining spaces, using reciprocal space closure (Fig. 10.64). The modules are normally stretched a little less than shown here. During this stage it is possible for the orthodontist to vary the anchorage according to the needs of the case, using Class II or Class III elastics or other methods (Chapter 8).

Fig. 10.61

Bracket repositioning is an accepted part of the technique, and there are appropriate times to do this. Premolar and other brackets will need to be repositioned in this case, as mentioned previously (page 203) and the lateral open bite relates to the vertical bracket positions. However, it is not efficient to suspend mechanics at this stage in the treatment, and go back to levelling and aligning after repositioning a few brackets. It is better mechanics to wait and reposition when picking up newly erupted teeth, which in this case will be the upper second molars (Figs. 10.73 to 10. 75).

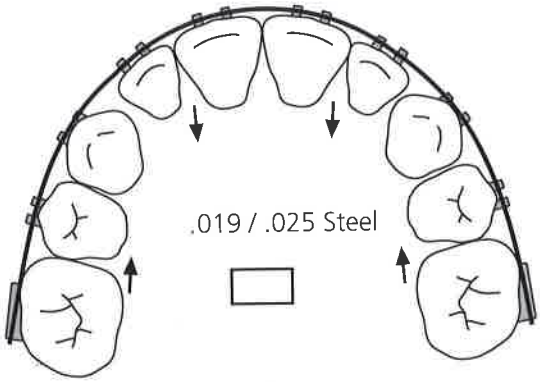


Fig. 10.64

Space closure has been completed and .019 / .025 steel wires remain in position (Figs. 10.67 to 10.72). Spaces are held closed with passive wire tiebacks (Fig. 10.70) while awaiting eruption of upper second molars. The second premolar brackets are not well positioned, which adversely affects the buccal occlusion, but will be corrected later.

Fig. 10.67

There are no bends in the wires, and the occlusal views (Figs. 10.71 & 10.72) show the excellent tooth alignment. In particular the in/out relationships in the lower anterior region are good, due to the accuracy of the brackets and the case set up. There will be further subtle improvements later in the treatment, because vertical repositioning of some canine and premolar brackets will also produce beneficial in/out changes.

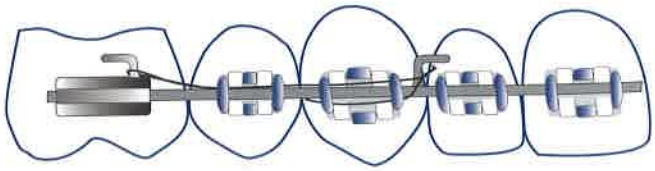


Fig. 10.70

Fig. 10.62

Fig. 10.63

Fig. 10.65

Fig. 10.66

Fig. 10.68

Fig. 10.69

Fig. 10.71

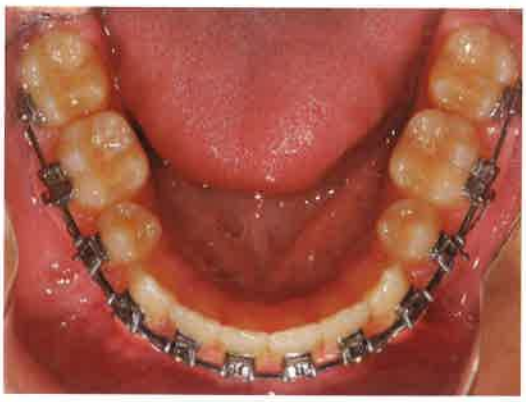


Fig. 10.72

Finishing and detailing. Tubes have been bonded on to upper second molars and there has been repositioning of brackets on premolars and other teeth. The case has been re-leveled and aligned, and is now in upper and lower .019 / .025 HANT wires (Figs. 10.73 to 10.78). It is vastly improved compared with the situation at the end of space closure (Figs 10.67 to 10.69) and this shows the importance of repositioning at appropriate times in the treatment.

A panoramic radiograph was taken to evaluate root positions (Fig. 10.76).

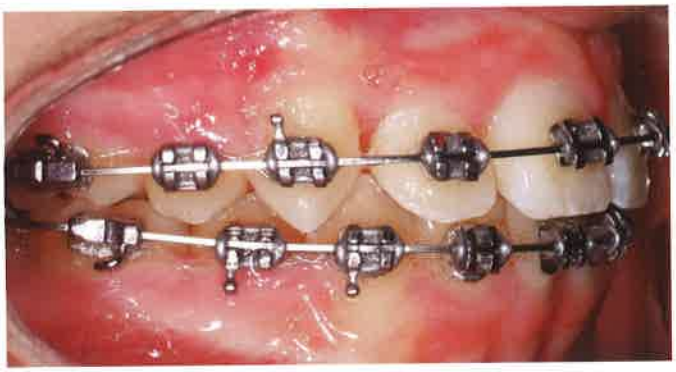


Fig. 10.73

Fig. 10.76

The case progressed to .019/.025 steel arch wires with active tiebacks, to correct final tooth positions and close minor spaces (Figs 10.79 to 10.81). At this stage it may be necessary to adjust for a tooth size discrepancy on the upper or lower anterior teeth to obtain an ideal occlusion. This is accomplished most often by IPR in the lower anterior region or composite build up of upper lateral incisors.

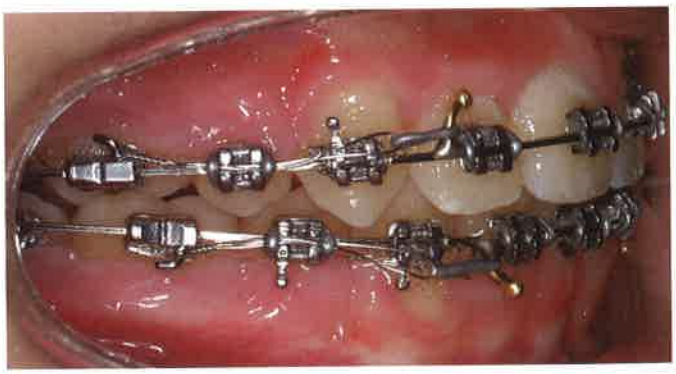


Fig. 10.79

During the final settling an upper .014 anterior sectional arch wire was placed (Figs 10.82 to 10.84), and the upper extraction sites were secured with figure 8 ligatures. These figure 8 ligatures should only include the canines and second bicuspids, and not the first molars (as seen here) to minimize the risk of molar rotation.

The .019 / .025 steel arch wire was continued in the lower arch, with passive tiebacks to hold the spaces closed. Light up and down elastics were used at night to settle the upper first molars.

Fig. 10.82

Fig. 10.74

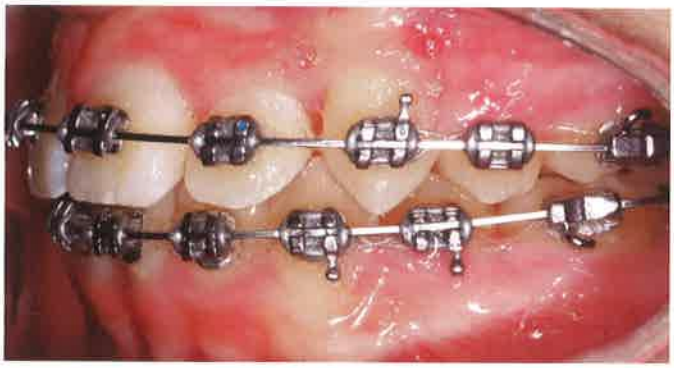


Fig. 10.75

Fig. 10.77

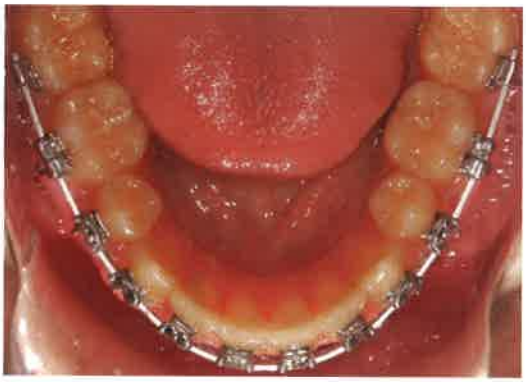


Fig. 10.78

Fig. 10.80

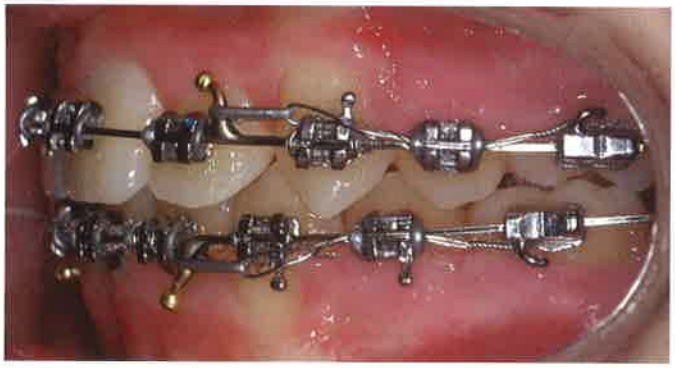


Fig. 10.81

Fig. 10.83

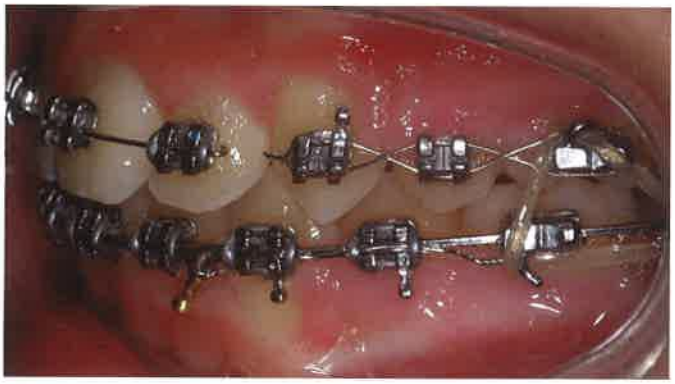
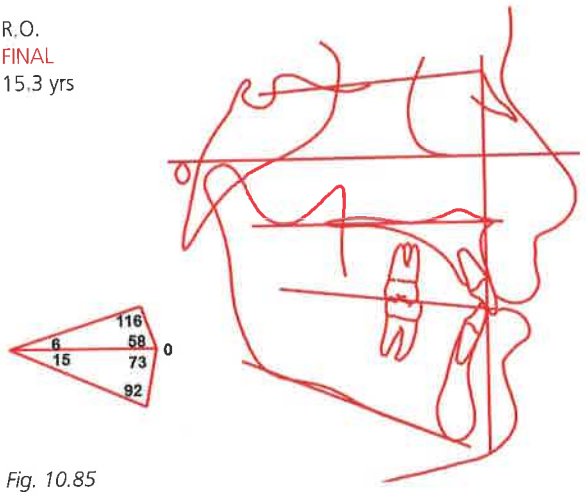


Fig. 10.84

The final intra-oral photos show a Class I occlusion. The upper second premolars were in a slightly Class II position, because they were slightly small compared with the lower second premolars. The panoramic radiograph showed a healthy occlusion, relatively parallel roots, and the presence of unerupted third molars.

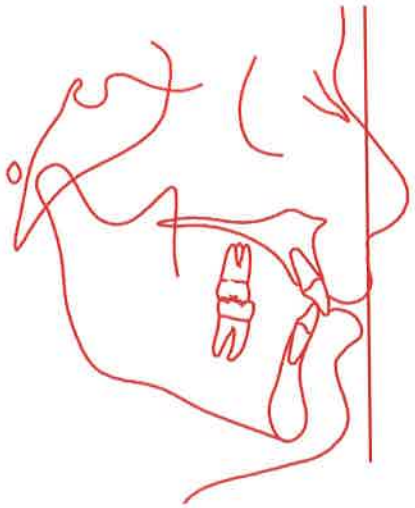
R.O.
FINAL
15.3 yrs



SNA 83°
SNB 81°
ANB 2°
A-N ⊥ FH -2 mm
Po-N ⊥ FH -5 mm
WITS 0 mm
GoGn SN 23°
FM 22°
MM 22°
↑1 to APo 6 mm
↓1 to APo 2 mm
↑1 to Max Plane 116°
↓1 to Mand Plane 92°

Fig. 10.85

R.O.
FINAL
15.3 yrs



↑ Incisor torque to occl. plane 55°
↑ Incisor tip to TVL -14 mm
↑ Lip thickness 16 mm
↑ Lip to TVL 1 mm

Max. anterior height 26 mm
↑ Lip length 22 mm
↑ Incisor exposure 4 mm
Inter-labial gap 2 mm

Occlusal plane to TVL 99°
↓ Incisor torque to occl. plane 69°
↓ Lip thickness 13 mm
↓ Lip to TVL -3 mm
Soft tissue 'B' point -11 mm
Soft tissue pogonion -8 mm

Fig. 10.86

The final facial photos and cephalometric tracings show that the patient continued to demonstrate a slight Class II facial and skeletal pattern. Upper lip thickness was adequate, but the upper incisor was a little retracted relative to TVL. This resulted in a slightly flat upper lip, despite good upper incisor torque control.

Summary

First premolar extraction treatment is controversial and can be difficult, but it is a necessary orthodontic treatment option. When treated properly, first premolar extraction cases can be completed to the highest quality standards of facial aesthetics, with good static and functional occlusion, and healthy TMJs and musculature.

Fig. 10.87

Fig. 10.88

Fig. 10.89

Fig. 10.90

Fig. 10.91

Fig. 10.92

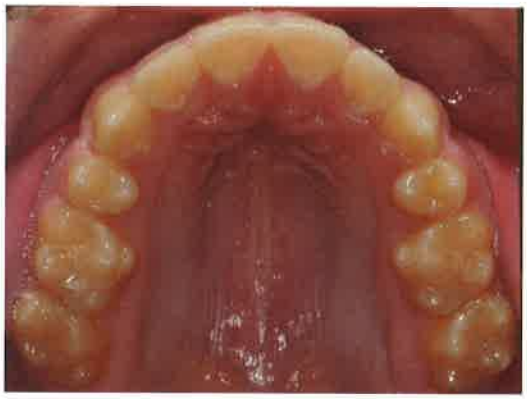


Fig. 10.93

Fig. 10.94

Fig. 10.95

R.O. BEG/FINAL
SN AT S

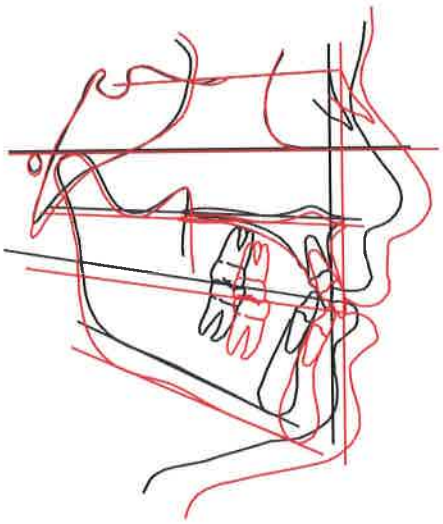


Fig. 10.96

R.O. BEG/FINAL

PALATAL PLANE AND
PALATAL CURVATURE

MAND SYMPHYSIS AND
MAND PLANE

Fig. 10.97

The superimposition of the beginning and final tracings on SN (Fig. 10.96) showed that the mandibular plane closed slightly, because vertical ramus growth was slightly greater than growth between SN and the palatal plane, as well as alveolar development in the upper and lower arches.

The maxillary superimposition showed an increase in the upper incisor torque and appropriate loss in molar anchorage to adequately keep up with good mandibular growth. The mandibular superimposition (Fig. 10.97) showed some retraction of the lower incisors, while maintaining the original molar position.

CHAPTER 11

Second premolar extraction treatment

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Second premolar extraction treatment

Introduction

Second premolar extraction treatment was discussed in the 1940s and 1950s by Nance, Dewel and Carey [1,2,3]. The reasons for extraction of these teeth were caries or large restorations, malformed [4] or abnormally small teeth, one or more missing second premolars, and local crowding, displacement or impaction. In these situations, the anchorage needs of the case may vary from minimum to maximum. The authors have previously reported on a case with extraction of lower second premolars of abnormal size and shape and mild anterior crowding (B2 p. 268).

Nance [1] also suggested that second premolars could be a good extraction choice for 'borderline' extraction cases with minimal crowding, where there was a need to avoid over-retraction of the incisors. This was based on the mathematical premise that when second premolars were extracted, there were eight teeth in front of the extraction sites, and hence greater resistance to incisor retraction, versus the six teeth present in first premolar extraction cases (Fig. 11.01). In a 2001 study [6] it was reported that more upper incisor retraction was found in cases where the upper first premolars were extracted, compared with a second premolar extraction group, but a wide range of individual variation was noted. A study of 26 second premolar extraction cases [5] found average incisor movement of 3.3 mm and 2.9 mm lingually in the maxilla and the mandible, respectively. The first molars moved mesially an average of 3.2 mm and 3.4 mm in the maxilla and the mandible, respectively.

During treatment planning, it is logical to assume that there is less anchorage available after second premolar extractions than from first premolar extractions, and this is the most common reason for choosing second premolars in borderline extraction cases. It is a treatment approach which has been favored by many leading orthodontists, including Dr. Lee Logan [7].

The extraction of second premolars

The authors have reviewed second premolar extractions in a previous text and shown the dental reasons why this extraction choice may be more appropriate than first premolar extractions (B2 Ch. 7). They have also discussed the elective loss of second premolars in cases where there is a need for minimal horizontal anchorage (B2 p. 263).

Orthodontic extraction of second premolars may be considered for treatment of two types of malocclusion:

1. *Cases with mild bimaxillary protrusion and little or no anterior crowding.* Patients with mild bimaxillary protrusion and little or no anterior crowding, where there is a need for only a small amount of retraction of upper and lower incisors. The authors have previously published a case (B1 p. 79) where full arch mechanics and reciprocal anchorage were successfully used. Lower incisors were retracted from APo +9 mm to APo +4 mm after loss of second premolars.

2. *Cases with mild anterior crowding, and a need to preserve the face.* Patients with mild or moderate anterior crowding, where there is a need to achieve good tooth alignment but preserve the face, with little or no change. The authors have previously shown a case (B2 p. 272) where normal full arch mechanics were used in the upper arch, and sectional mechanics (followed by full arch mechanics) in the lower, to achieve ideal tooth alignment. The profile was maintained and lower incisor position only changed from APo +4 mm to APo +3 mm during treatment.

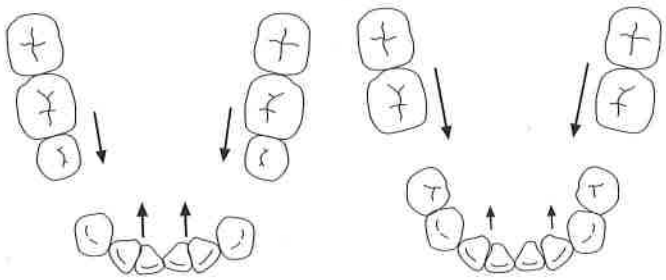


Fig. 11.01 During treatment planning it can be assumed that there is less anchorage from second premolar extractions than from first premolar extractions, provided treatment is started without delay.

Full arch mechanics

Full arch mechanics are normally recommended if there is no anterior crowding, as with many protrusive cases. Brackets and tubes can be initially placed on all teeth, from first molar to first molar. Arches can quickly be levelled to rectangular steel wires, followed by space closure with en masse retraction, using active tie backs (B1 p. 79). The second molars are often best left without tubes and allowed to drift mesially.

If extraction is due to dental reasons, which is less common, posterior anchorage may be required. The normal methods can be used, such as palatal bars, Nance arches, headgears, lingual arches, and possibly temporary anchorage devices [8] or plates (page 111).

Early management of the extraction sites

This chapter has a focus on cases with elective loss of second premolars for orthodontic reasons. Normally anchorage needs are minimal, and anchorage loss is required. The key factors concerning anchorage management in these cases are the width of bone in the extraction sites, the timing and method of space closure, and torque control in the anterior segments. Three important steps are recommended:

1. *Starting space closure without delay.* At the beginning of treatment, it is important to begin second premolar extraction site space closure without delay. This is because bone narrowing in this site can occur within a three to six months (Fig. 11.02). If this occurs, mesial movement of the wide first molars is more difficult. As an undesirable outcome, greater anchorage is achieved and more retraction of the incisors may occur.

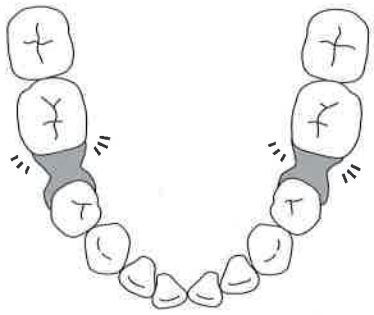


Fig. 11.02 If there is bone narrowing in the extraction site, it can restrict the mesial movement of molars. Accordingly, space closure of the second premolar extraction site should begin without delay in cases where there is a need for minimal anchorage.

2. *Preventing tipping into the extraction sites.* As with first premolar extraction cases, it is important to minimize tipping of teeth into the second premolar extraction sites during the initial process of extraction site closure (Fig. 11.03). Unwanted tipping will extend the length of treatment, because of the extra time required to parallel roots. Therefore, if sectional mechanics are used, there should be adequate stiffness in arch wire. Minor gable bends in the extraction site (page 217) are also helpful, to parallel roots.

3. *Adding lower lingual and upper palatal root torque to incisors if needed.* When the arches have been fully bonded and levelled to rectangular steel wires, it is often helpful to add lower lingual and upper palatal root torque in the incisor areas, to create resistance to over-retraction of incisors (Fig. 11.04).

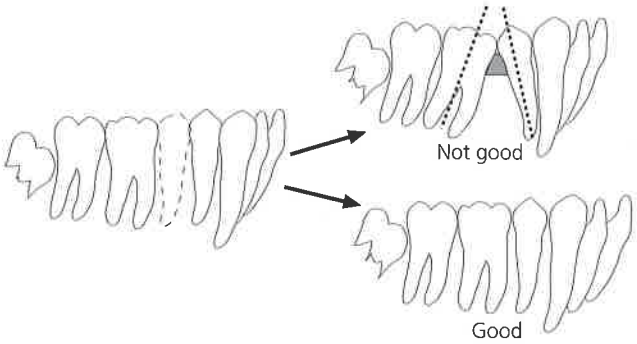


Fig. 11.03 It is important to minimize tipping of teeth into the second premolar extraction sites during closure of the extraction site. Tipping can occur if the sectional wires are not thick enough, or the forces are too high. Sectional steel wires of .017 /.025 or .019 /.025 are used, and light forces from lace backs are recommended. This normally takes six to eight months.

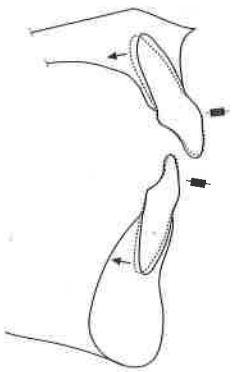


Fig. 11.04 At the rectangular steel wire stage it is helpful to add root torque in the incisor areas, as shown. This creates resistance to over-retraction of incisors.

Using sectional mechanics

Whenever anterior crowding is present in second premolar extraction cases, sectional wires can be effectively used to accomplish the three goals listed above. Modified lacebacks and then sectional wires (Figs. 11.05 – 11.09) are placed from first premolars to first molars to begin closure of second premolar extraction sites. The six anterior teeth are not included in the set up, and this allows early use of heavier wires, which means that tooth movements can begin with minimal tipping.

The technique of pre-alignment with sectional wires is popular with patients, because there are no appliances on the front teeth during the first six to eight months of treatment.

Fig. 11.05 The case is set up in the normal way, with bands or bonded tubes on first molars and bonded brackets on first premolars. If bands are used for molars, they should have lingual or palatal buttons or cleats. Modified lacebacks are placed from first molars to first premolars. These should be passive, and should not be overtightened to produce blanching of the tissue.

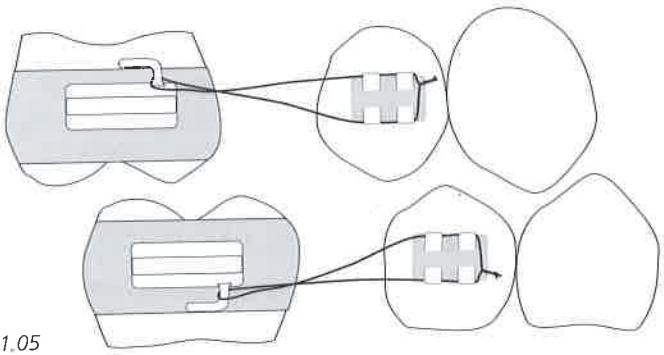


Fig. 11.05

Fig. 11.06 Sectional steel .020 round wires are placed. Before placement, the ends of the wires are flamed to ensure proper tucking in, mesially and distally. The sectional wires are held in place by a module or a wire ligature, and the patient is normally seen in about four weeks. It is possible for the .020 round wires to rotate after placement, so that the ends become troublesome. For this reason some orthodontists prefer to start the treatment with .0175 / .025 or .019 / .025 rectangular steel sectional wires. They do not rotate, but it is sometimes necessary bend them a little to ensure they are passive, if used to start the case.

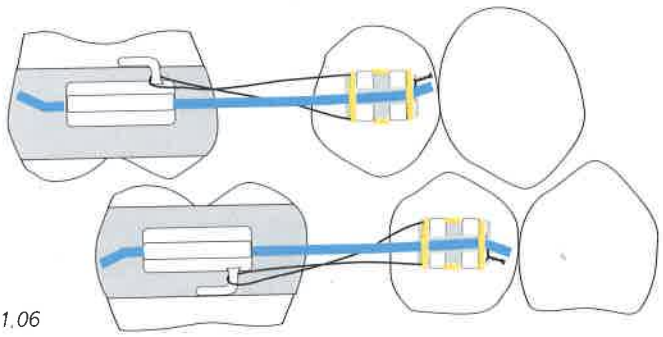


Fig. 11.06

Fig. 11.07 At the first adjustment visit the .020 wire is removed. The laceback should be tightened to 'take up the slack', but it should not be overtightened. Normal .009 or .010 ligature wires are used for the passive modified lacebacks, and they produce gradual closure of the extraction site at a rate of 1.0 mm to 1.5 mm per month. There is a 'trampoline effect' from food items during mastication. Sectional .017 /.025 or .019 /.025 wires can be placed, and as with the round wires, the ends are flamed to allow good placement of proper bend backs.

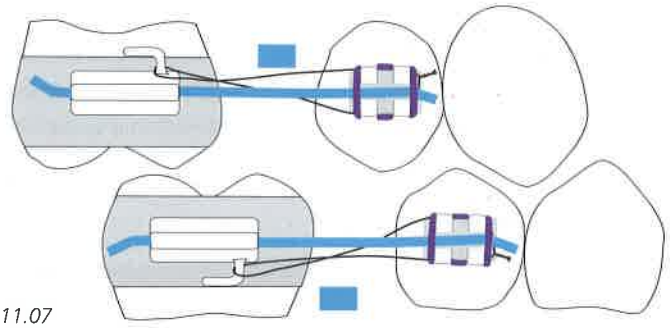


Fig. 11.07

Fig. 11.08 If sectional .017 / .025 steel wires are used, minor gable bends are often beneficial to help in achieving good root parallelism. If inaccurate or narrow brackets are used, gable bends will normally be needed.

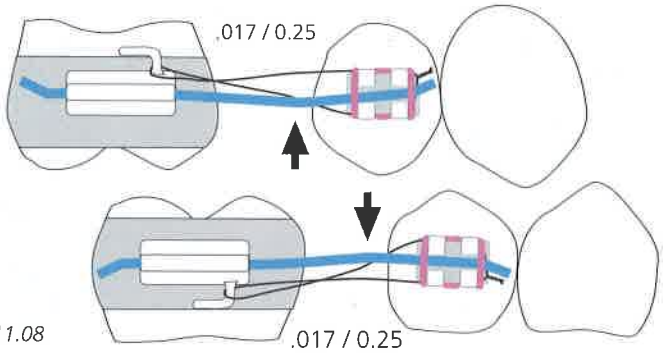


Fig. 11.08

Fig. 11.09 Gable bends should not be needed if sectional .019 / .025 steel wires are correctly used in an accurately manufactured .022 bracket, of adequate width [9]. In this situation, tip should be accurately expressed within 2° of the prescription, and there will be good root paralleling. However, if inaccurate or narrow brackets are used, gable bends may be needed, even when using sectional .019 / .025 steel wires.

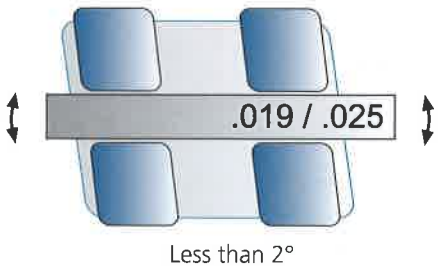
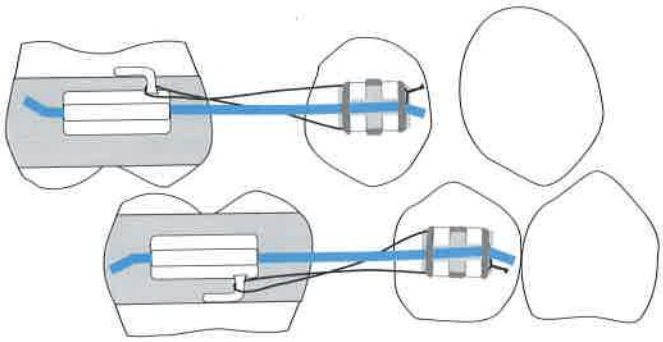


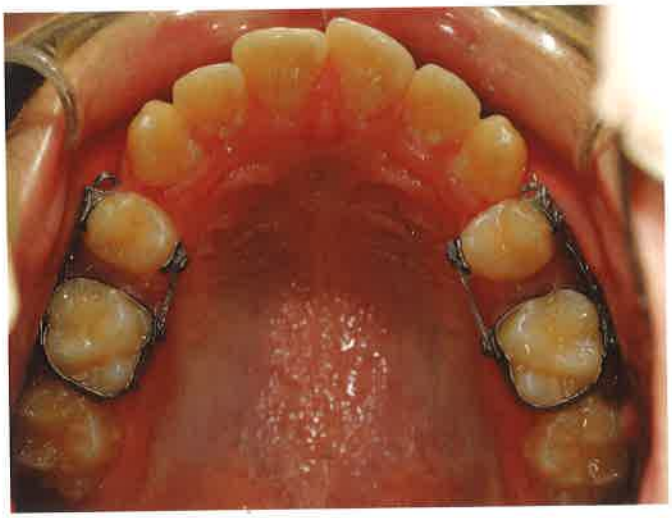
Fig. 11.09

Light palatal and lingual elastic chains

Light forces from lacebacks are used to achieve nearly parallel roots as the extraction site is closed, which normally takes six to eight months. When using sectional steel rectangular wires, light elastic chains can be attached to palatal or lingual buttons or cleats from first premolars to first molars. This helps in rotation control and space closure (Figs. 11.10 & 11.11). They are very effective and are not needed at every visit. Rotational movement can be watched, and elastic chains used as necessary.



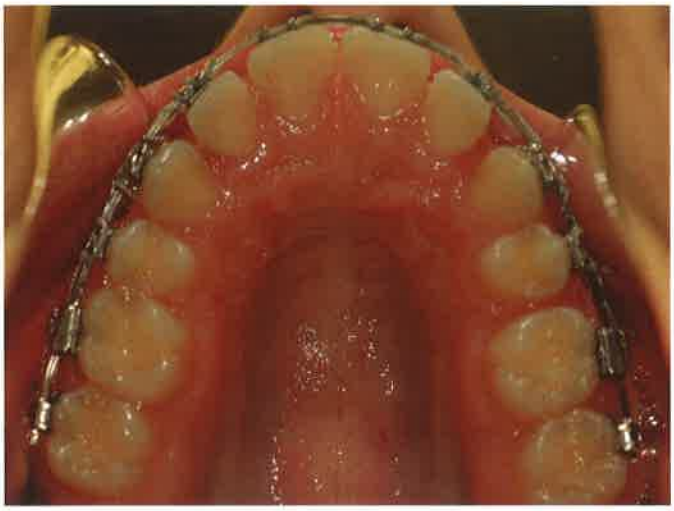
Figs. 11.10 & 11.11 Light forces from lace backs can be used to achieve nearly parallel roots as the extraction site is closed, which normally takes six to eight months. (See also case report NH page 222). In the case shown here .017 / .025 wires are in place and there is a minor gable bend in the lower wire. Each first premolar bracket is tied with a wire ligature, to prevent rotations, and these brackets have a module on top of the ligature.

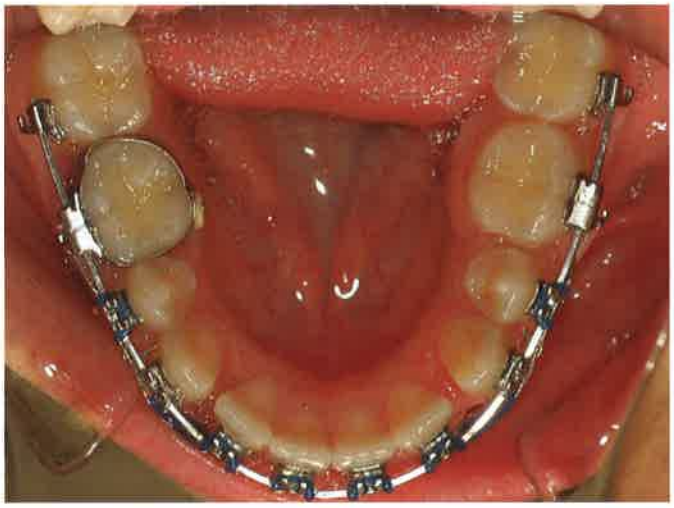


Figs. 11.12 & 11.13 With rectangular steel sectionals, light elastic chains can be attached to palatal or lingual buttons or cleats from first premolars to first molars, to help in rotation control if required. They are not needed at every visit.

Levelling and aligning

Sectional wires are used to achieve adequate space closure, sufficient to eliminate crowding in the anterior segments. After this 'pre-alignment' the treatment can continue much like a non-extraction case (Figs. 11.14 & 11.15). Brackets can be placed on the anterior teeth and tubes on the second molars, if needed. Levelling and aligning is achieved, while using lacebacks or figure eight ligature wires (from the first premolars to the first molars) to hold the extraction sites closed. Overbite control begins to occur, because of the inclusion of all teeth. If necessary, turbos (page 172) can be used to eliminate interferences with brackets and to help bite opening.

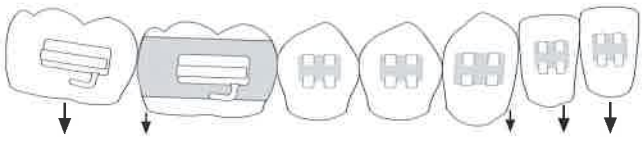




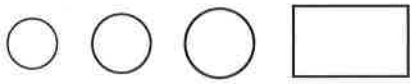
Figs. 11.14 A and 11.14 B After the 'pre-alignment' phase, a second premolar extraction case (seen here) continues like a non-extraction case. Brackets are placed on the anterior teeth and tubes on the second molars, for levelling and aligning. Normal lacebacks hold the extraction sites closed. The 10° rotation control of the upper first molar tubes can be seen, with zero rotation in the lower first molars. Mini second molar tubes are in place, and the lower arch wire is protruding by the recommended small amount distally. The precise in/out specification of the bracket system can be seen, particularly in the lower incisor area.

Overbite control

The requirements for overbite control in deep bite cases are discussed on page 90. They the same in second premolar extraction cases as with other treatment options, and it is normally essential to include the lower second molars in the set up (Fig. 11.15A). Steel round wires should be used, followed by the normal rectangular steel .019 / .025 wires, in cases where the curve of Spee needs to be controlled (Fig. 11.15B). HANT wires are less effective. It is usually easier mechanically to correct a deep bite in non-extraction cases. If there is a reduced anterior overbite (as with Case NH page 222) the mechanics are normally easier if premolars have been extracted.



Figs. 11.15A The requirements for overbite control are the same in second premolar extraction cases as with other treatment options. It is normally essential to include the lower second molars in the set up in deep bite cases.

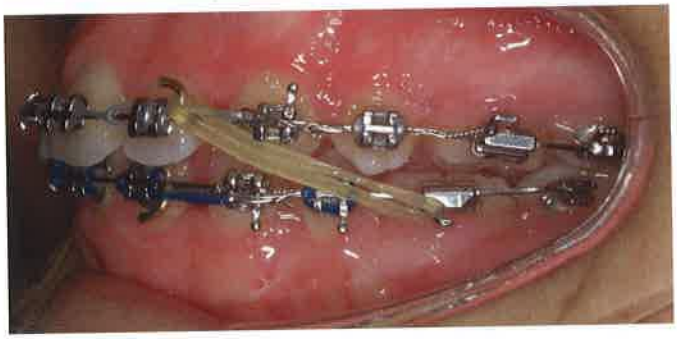


.022 slot and steel wires

Figs. 11.15B The .022 slot is recommended, and steel round wires should be used, followed by the normal steel .019 / .025 wires, in cases where a curve of Spee needs to be corrected. Time is needed for the mechanics to have effect.

Space closure and overjet correction

After levelling and aligning to .019 / .025 stainless steel wires, space closure can be completed with active tiebacks. If needed, intermaxillary elastics can be used for antero-posterior and asymmetry correction (Figs. 11.16 – 11.18).



Figs. 11.16, 11.17 & 11.18 In this second premolar extraction case, brackets have been placed on the anterior teeth and tubes on the second molars. The normal .019 /.025 working steel wires are in place after levelling with HANT wires. Class II elastics are being used to correct a minor midline discrepancy and to improve the buccal occlusion on the left side. Space closure can be completed with .019 /.025 steel wires and active tiebacks, as described for first premolar extraction cases in chapter ten.

Figs. 11.19, 11.20 & 11.21 The same second premolar extraction case as seen above after completion. The final intra-oral photographs show space closure of the extraction sites and a Class I occlusion.

Finishing and retention

The usual settling and retention procedures can be followed in these cases, as described in chapters 12 and 13. If third molars are present and there has been good root paralleling, extraction sites normally tend to stay closed. When there are concerns, a night time wraparound lower retainer (page 258) may be considered, in addition to a lower anterior bonded retainer.

Archwire sequencing

Archwire sequencing for typical second premolar extraction cases with anterior crowding can be summarized as follows:

1. Sectional round wires of .020 stainless steel and lacebacks are usually placed initially between first premolars and first molars. These .020 round wires can sometimes rotate after placement, and then the wire ends become troublesome. For this reason, some orthodontists prefer to begin with .0175 / .025 sectional wires as in (2) below, and if necessary bend them a little to ensure they are passive.
2. .0175 / .025 or .0195 / .025 sectional wires follow the round sectional wires. They are initially placed without gable bends. Small gable bends (Fig. 11.08) are normally placed at the next visit for root control, if .0175 / .025 sectional wires are used.
3. After extraction sites are closed enough to eliminate anterior crowding, brackets and tubes are placed on the remaining teeth, and full arch levelling .016 HANT wires are placed.
4. The case goes to .0195 / .025 HANT wires after the .016 HANT wires have served their purpose. If there is a deep or open overbite, steel round .018 and .020 wires are considered, to help control of the curve of Spee.
5. The normal working .0195 / .025 stainless steel wires with soldered hooks are placed to complete levelling, torque control and final space closure.
6. As with other extraction choices, and non-extraction cases, settling wires are normally used briefly before appliance removal, as discussed in chapter twelve.

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B1 Bennett J, McLaughlin R P. 1993 Orthodontic treatment mechanics and the preadjusted appliance. Mosby-Wolfe, London ISBN 0 7235 1906X

B2 Bennett J, McLaughlin R P. 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford ISBN 1 899066 91 8. Republished in 2002 by Mosby, Edinburgh ISBN 07234 32651

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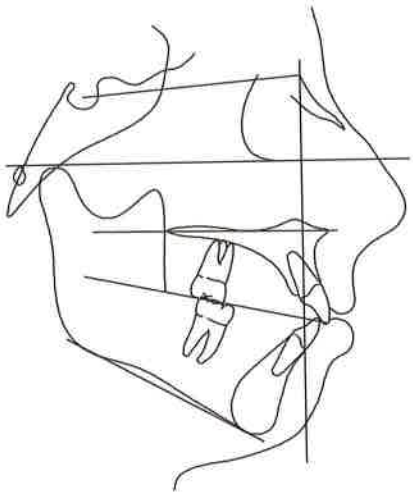
9. Bennett J. Fundamentals of orthodontic bracket selection. Second edition. 2010 p. 39 Le Grande publishing. Opal Orthodontics, Utah. ISBN 978-0-9564555-1-2

Case report NH

A male patient, aged 12.3 years, with a Class II skeletal and facial pattern. The posterior dental relationship was Class I bilaterally, with a slight anterior open bite and moderate anterior crowding. The panoramic radiograph confirmed a healthy dentition and the presence of unerupted third molars. The lower second premolars were large, and showed atypical crown anatomy. The case shows a technique used by the authors to treat second premolar extraction cases with anterior crowding.

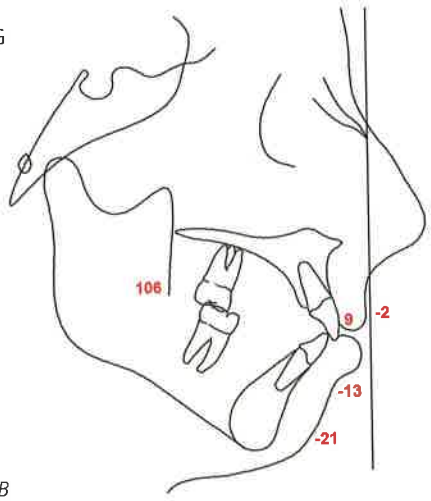
N.H.
BEGINNING
12.3 yrs



SNA 89°
SNB 82°
ANB 7°
A-N ⊥ FH 4 mm
Po-N ⊥ FH -9 mm
WITS 1 mm
GoGn SN 29°
FM 28°
MM 28°
↑1 to APo 10 mm
↓1 to APo 7 mm
↑1 to Max Plane 116°
↓1 to Mand Plane 102°

Fig. 11.22A

N.H.
BEGINNING
12.3 yrs



↑ Incisor torque to occl. plane 52°
↑ Incisor tip to TVL -12 mm
↑ Lip thickness 9 mm
↑ Lip to TVL -2mm

Max. anterior height 21 mm
↑ Lip length 18 mm
↑ Incisor exposure 3 mm
Inter-labial gap 2 mm

Occlusal plane to TVL 106°
↓ Incisor torque to occl. plane 61°
↓ Lip thickness 12 mm
↓ Lip to TVL -4 mm
Soft tissue 'B' point -13 mm
Soft tissue pogonion -21 mm

Fig. 11.22B

Cephalometrically, the patient's upper incisors showed adequate torque. However, they were slightly retrusive relative to TVL, and the upper lip was thin. The result was a very flat upper lip. The ANB angle was 7° and the Wits was 1 mm, indicating a steep occlusal plane, which resulted in a retrusive mandible. The lower incisors were flared anteriorly.

The facial profile of this patient could not be improved significantly without surgical intervention. Surgical intervention on such cases is often rejected. Therefore, the goal of treatment was to maintain the profile, while correcting the anterior dental crowding. The overbite and overjet was to be corrected by retracting the lower incisors 1 mm and by slightly deepening the curve of Spee.

Fig. 11.23

Fig. 11.24

Fig. 11.25

Fig. 11.26

Fig. 11.27

Fig. 11.28

Fig. 11.29

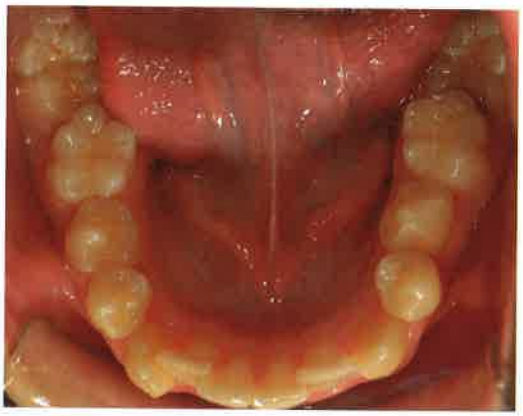


Fig. 11.30

Fig. 11.31

Early management of extraction sites is needed. After the second premolars were extracted, first molars were banded with lingual buttons and first premolar brackets were bonded. Lacebacks were placed, along with .020 round sectional wires (Fig. 11.35). Other teeth were not bracketed, which allowed these large round wires to be used as initial wires. The patient did not have brackets on the anterior teeth for the first 7 months of treatment.

Care is needed, because the .020 round wires can sometimes rotate after placement, so that the ends become troublesome. For this reason, some orthodontists prefer to start with rectangular .0175/.025 sectional wires (below) and if necessary bend them a little to ensure they are passive.

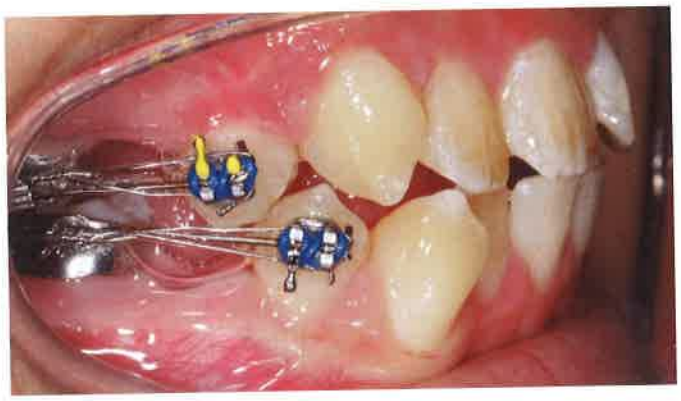


Fig. 11.32

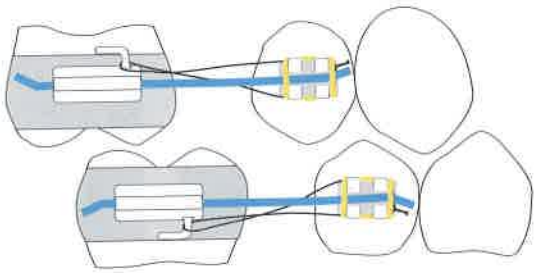
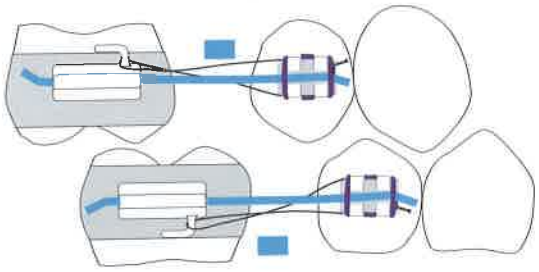


Fig. 11.35

At this second visit, lacebacks were gently tightened and .017/.025 sectional wires were placed (Figs. 11.38 A & B). Normally lacebacks become a little loose during four weeks, and it is necessary to 'take up the slack', but not over-tighten them to cause blanching of the soft tissue, as this can lead to unwanted tipping and rotation. Lingual buttons were added to the first premolars, and light elastic chains were placed lingually and palatally. Patients are normally seen at 4 to 6 week intervals, depending on the stage of treatment and the level of cooperation. At the following visit, minor gable bends were placed in the sectional wires to minimize tipping during extraction site closure.

Fig. 11.38A



.017 / .025 or .019 / .025

Fig. 11.38B

Fig. 11.33

Fig. 11.34

Fig. 11.36

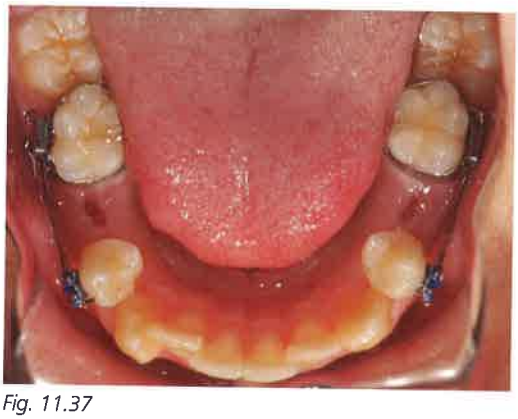


Fig. 11.37

Fig. 11.39

Fig. 11.40

Fig. 11.41

Fig. 11.42

These two sequences show the closure of upper and lower extraction sites using sectional wires, over a seven month period. Crowding was reduced in the upper and lower anterior segments, without the need for anterior brackets. Minimal tipping has occurred as the extraction sites closed, which is important. Tongue pressure has improved the alignment of the lower right lateral incisor.

Elastic chains are needed on the lingual and palatal sides of the teeth from time to time. They are used to assist rotation control and space closure, but are very effective and are not needed at every visit. Rotational movement can be watched, and elastic chains used as necessary. Interestingly, the impacted lower left second molar did not improve during this time. The impaction was due to the incorrect angulation of its eruptive path (see panoramic radiograph page 223) and it is doubtful the molar band restricted spontaneous correction.

Upper arch treatment sequence

Lower arch treatment sequence

After eight months of treatment, the anterior teeth were bracketed, and full arch mechanics were started. The normal .016 HANT wires were placed to begin levelling and aligning, with bend backs, and the case could be managed like a non-extraction treatment. 'Figure eight' ligature wires are often helpful across the extraction sites at this stage, to maintain space closure.

Levelling and aligning proceeded efficiently, and there were no issues with overbite control in this case.

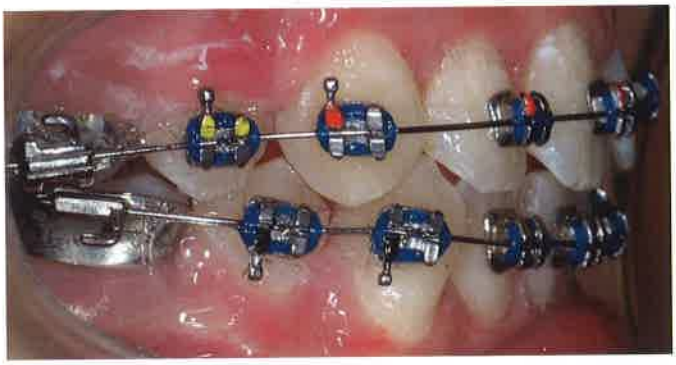
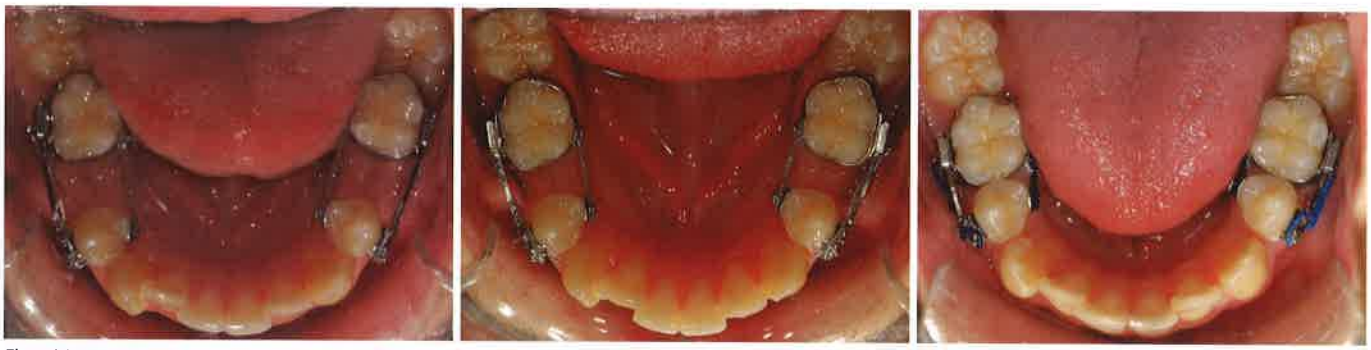


Fig. 11.49

Figs. 11.43, 11.44 & 11.45



Figs. 11.46, 11.47 & 11.48

Fig. 11.50

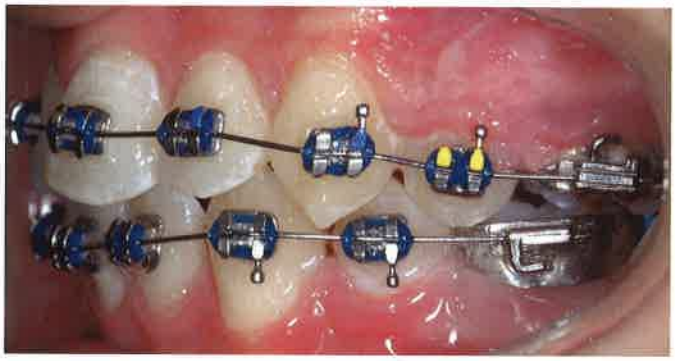


Fig. 11.51

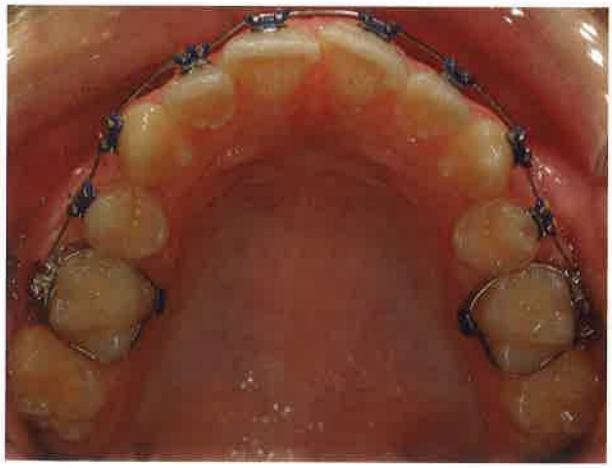


Fig. 11.52

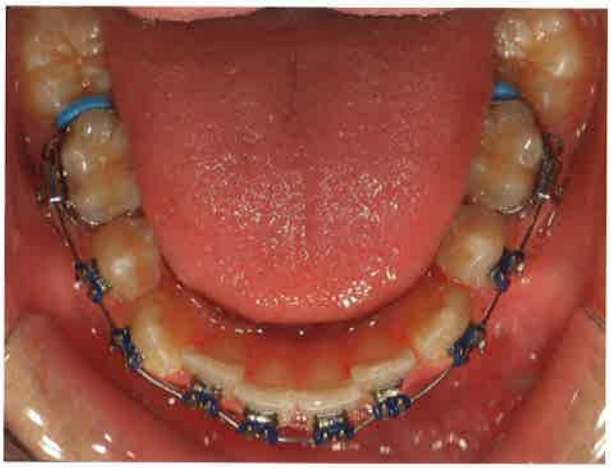


Fig. 11.53

At this stage upper and lower .020 stainless steel wires were placed, with lacebacks to maintain closure of the extraction sites. Separators continued in the lower left second molar area. Normally, these arch wires and the following rectangular stainless steel arch wires would encourage bite opening or bite closure. However, in this case overbite control needs were minimal.

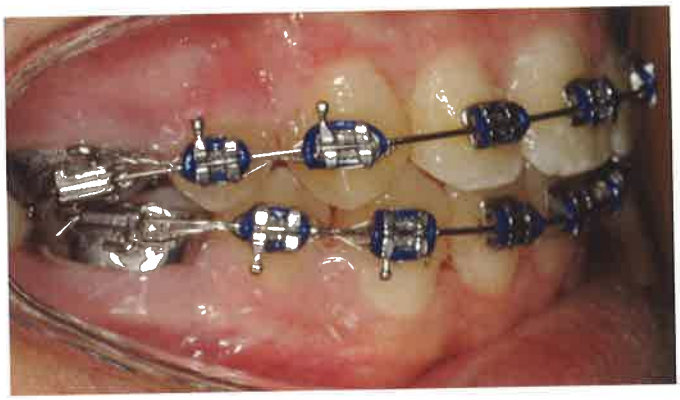


Fig. 11.54

An upper .019/ .025 SS arch wire was placed with active tiebacks to complete space closure. Lower second molars were bonded using mini tubes, and a lower .019 x .025 heat activated wire was placed to start second molar correction.

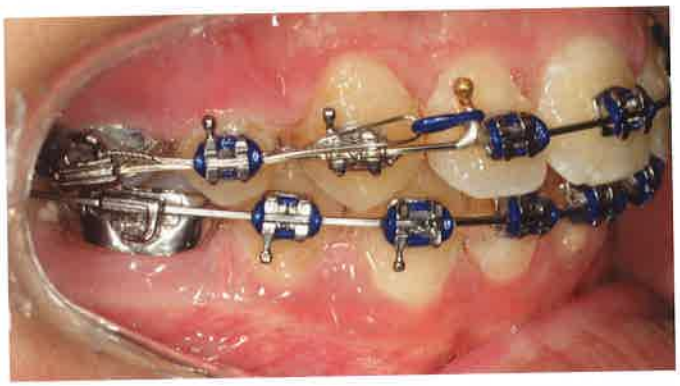


Fig. 11.57

In the final stages of treatment it was necessary to correct a tooth size discrepancy between upper and lower incisors. Unusually, the uppers were oversized, compared with the lowers. Interproximal enamel reduction (IPR) was needed distal to the upper central incisors and mesial to the upper lateral incisors.

An upper .020 SS wire was placed with a light elastic chain to complete space closure and final overjet correction (Fig 11.63). A lower .019x.025 stainless steel wire was placed to complete correction of the lower second molar rotations.

Fig. 11.60

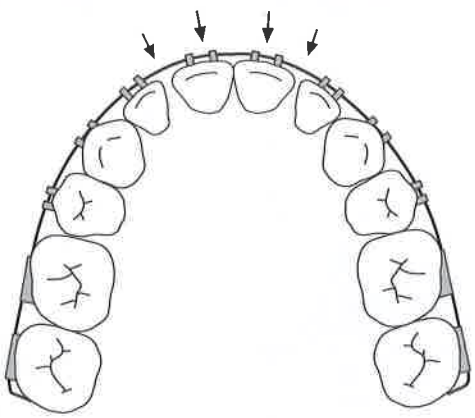


Fig. 11.63

Fig. 11.55

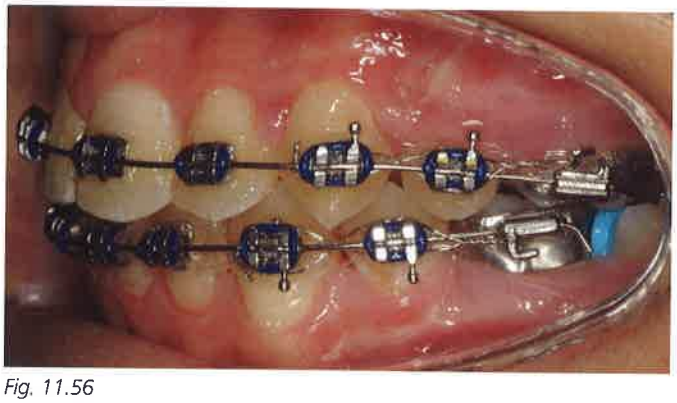


Fig. 11.56

Fig. 11.58

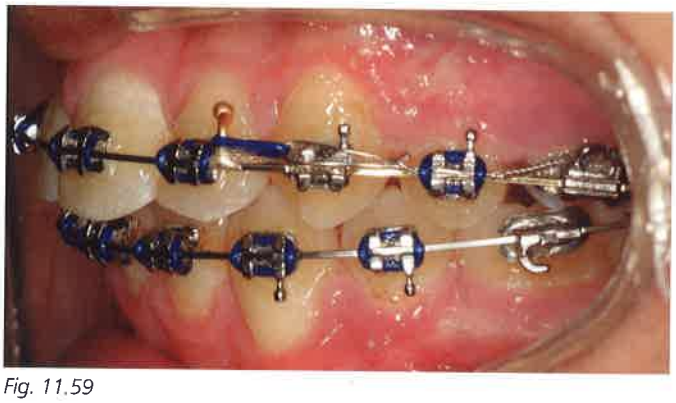


Fig. 11.59

Fig. 11.61

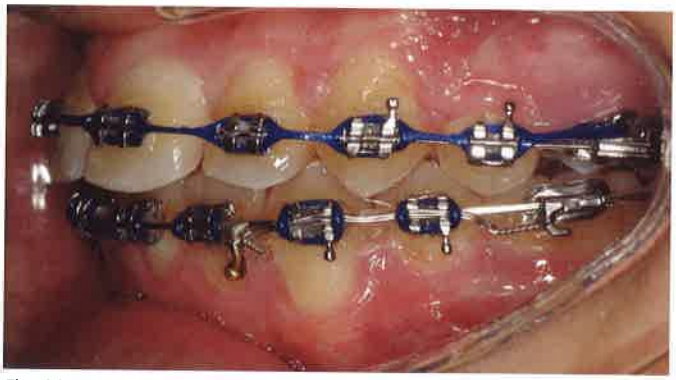


Fig. 11.62

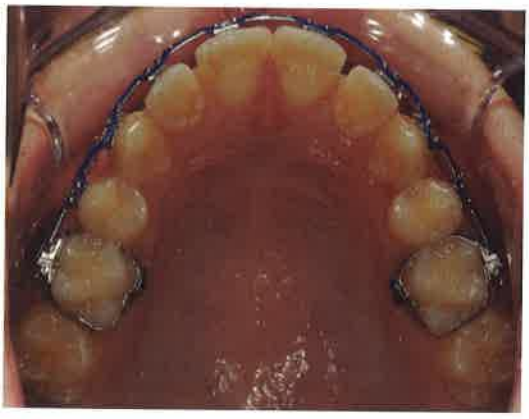


Fig. 11.64

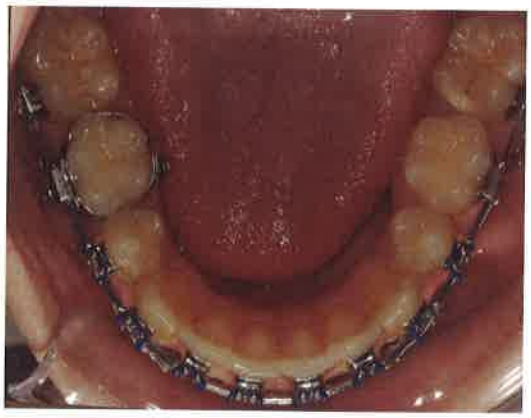
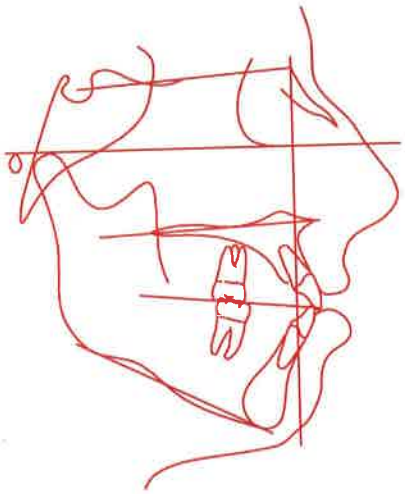


Fig 11.65

The final facial photos showed a profile that was not *significantly changed. Frontally, the patient had good symmetry and a pleasing smile. Intra-oral photographs showed a Class I occlusion with adequate overbite and overjet. The final panoramic radiograph showed good paralleling of roots.

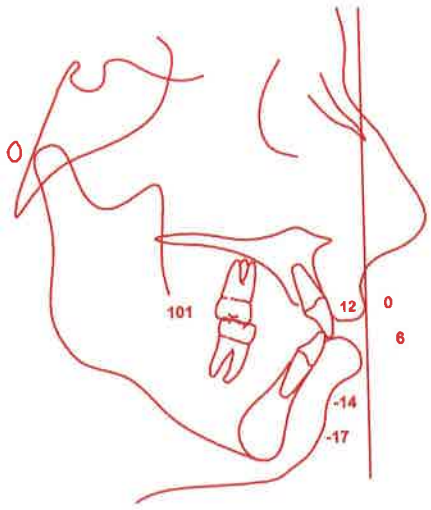
N.H.
FINAL
14.11 yrs



SNA 87°
SNB 84°
ANB 3°
A-N ⊥ FH 1 mm
PO-N ⊥ FH -6 mm
WITS 0 mm
GoGn SN 27°
FM 26°
MM 29°
↑1 to APo 10 mm
↓1 to APo 8 mm
↑1 to Max Plane 116°
↓1 to Mand Plane 94°

Fig. 11.66

N.H.
FINAL
14.11 yrs



↑ Incisor torque to occl. plane 55°
↑ Incisor tip to TVL -13 mm
↑ Lip thickness 12 mm
↑ Lip to TVL 0 mm

Max. anterior height 22 mm
↑ Lip length 17 mm
↑ Incisor exposure 5 mm
Inter-labial gap 6 mm

Occlusal plane to TVL 101°
↓ Incisor torque to occl. plane 65°
↓ Lip thickness 15 mm
↓ Lip to TVL -3 mm
Soft tissue 'B' point -14 mm
Soft tissue pogonion -17 mm

Fig. 11.67

The final tracings showed adequate torque of the upper incisors, and more uprighting of the lower incisors. When mandibular growth is good, as was seen on the superimpositions on page 232, the contact of the lower incisors with the upper incisors often causes additional lower incisor uprighting. This is clearly seen in many Class III cases, when lower incisor uprighting can be extreme. The upper incisors were still slightly retrusive relative to TVL, and the upper lip remained thin, with some flatness in the upper lip area. The occlusal plane angle was five degrees flatter than in the original tracing, however it was still relatively steep, creating some chin retrusion. Third molars were extracted, and supplemental upper third molars were evident on the panoramic radiograph.

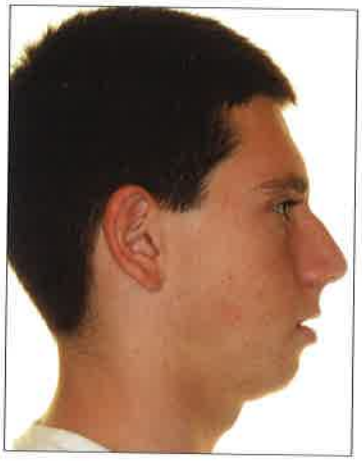


Fig. 11.68

Fig. 11.69

Fig. 11.70

Fig. 11.71

Fig. 11.72

Fig. 11.73

Fig. 11.74

Fig. 11.75

Fig. 11.76

N.H. BEG/FINAL
SN AT S

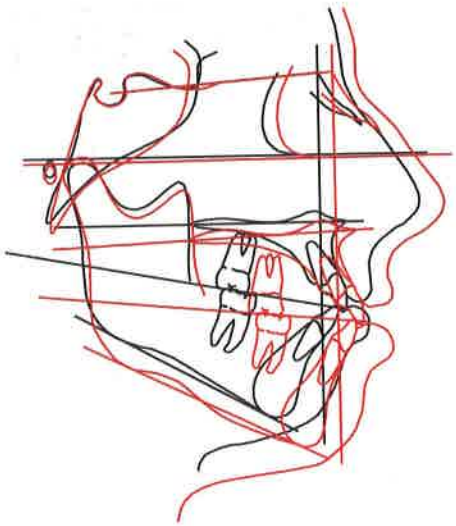


Fig. 11.77

N.H. BEG/FINAL

PALATAL PLANE AND
PALATAL CURVATURE

Fig. 11.78

MAND SYMPHYSIS AND
MAND PLANE

Fig. 11.79

The superimpositions showed that good mandibular growth occurred during the treatment period. In this situation the contact between upper and lower incisors often causes lower incisor uprighting, and this was seen in the mandibular superimposition.

The upper incisor position showed little change, and the upper lip remained thin, resulting in some flatness of the profile in the area. The palatal superimposition showed the planned mesial movement of the upper molars was achieved, using sectional mechanics, which avoided unwanted retraction of the upper incisors.

CHAPTER 12

Settling the case

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Settling the case

After the main features of the malocclusion have been corrected, final tooth movements are needed to take the case to completion. This can be a challenging time for the orthodontist. First, there is a need to identify what has to be done. This is not always easy, and a set of snap study models can be helpful, or a cephalometric or panoramic radiograph in some instances. Second, there is the need to achieve good settling without losing what was achieved earlier in the treatment. Patients should be seen every week during the settling period. It is helpful to consider the finishing stages of an orthodontic treatment in three steps:

- The correction of errors made before finishing
- Overcorrection
- Case settling

The correction of errors

It is recommended that the technique should be practiced as a complete approach, which normally leads to high quality results. Previous books and earlier chapters in this text provide information on diagnosis, treatment planning and mechanics, and these are intended to minimize errors during the main part of the treatment.

However, even if all the guidelines and recommendations are followed, mistakes can be made, and these need to be corrected in the finishing process. For example, a bracket positioning error may be missed during the main tooth movement stages, but become obvious later in treatment, as the teeth approach ideal occlusion. At that stage some bracket repositioning will be needed to finish the case (Figs. 12.01 & 12.02 and case RO page 201).

Overcorrection

Overcorrection is an accepted principle in good orthodontics. As a rule it is wise to overcorrect whatever is known to have a risk of relapse, in particular overjet and horizontal discrepancies, and tooth rotations. Class II cases can be corrected to an ideal position, and then maintained with Class II elastics at night time for four to six weeks. If relapse occurs, then the Class II elastics can be worn full time to bring the bite to an edge to edge relationship. This is then followed by the night time protocol, and the case usually settles to a corrected position, if a correct diagnosis and treatment plan was made. Class III cases are more difficult, because of the risk of Class III growth after treatment. These cases can be overcorrected routinely by approximately 2 mm, and then maintained with Class III elastics at night time for two to three months. If relapse occurs, then the Class III elastics can be worn full time to bring the bite to overcorrection. This is then followed by the night time protocol. The possibility of continued Class III growth is always present in patients up to age 20 years, particularly if there is a family history, so there should be no hurry to remove appliances in these cases. Deep bite and open bite cases can be overcorrected, followed by the protocols discussed in chapter 14.

When possible, tooth rotations should be corrected early in treatment, so they can be held for many months before appliance removal, and conventional twin brackets are recommended to provide the necessary control for this at the start of treatment (page 35). It has also been reported that conventional twin brackets are preferred by orthodontists when finishing cases [1]. To ensure that full correction of rotations has been achieved, the authors favor a small amount of overcorrection, which can be held for two or three visits.

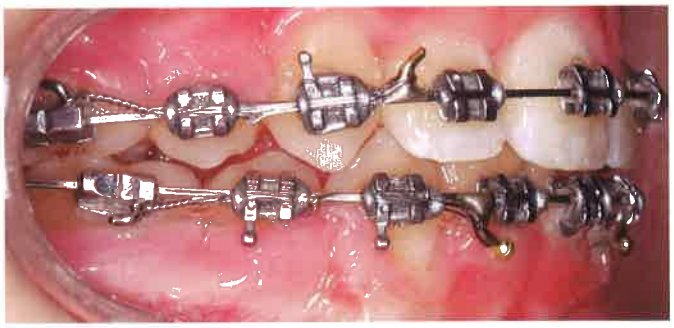

Fig. 12.01 In this case bracket repositioning was needed at the settling stage to correct earlier errors.

Fig. 12.02 The same case as Fig 12.01, after bracket repositioning and settling.

Case settling

Many orthodontists are reluctant to allow cases to settle before appliance removal, preferring to move directly into retainers from the secure control of .019 / .025 rectangular steel wires or rectangular HANT wires. This reluctance comes from a concern that during the settling process unwanted changes may occur among previously corrected teeth.

We have to accept that some changes are going to occur whether appliances are present or not. At times these changes may be negative, but it is better to see them while appliances are on and corrections can be made, without having to replace the appliance.

When finishing the case, it is important to have a protocol that minimizes negative changes while the teeth settle. There are frequent options for the upper and lower arches during settling. They are used in different combinations, depending upon the needs of the case. During settling teeth next to extraction sites should be lightly tied together, to prevent spaces opening.

Frequent lower arch options

The .016 HANT settling wire

This is the most commonly used option in the lower arch. It is recommended if the lower arch shows good alignment, and the occlusion is close enough to an ideal relationship to require only one or two weeks of settling. This wire is flexible enough to allow for transverse arch settling, while maintaining individual tooth alignment. The use of triangular elastics, when needed, will not distort the arch form in this short time, and the loose fit of the .016 wire in a .022 slot will allow minor vertical settling (Fig. 12.03).

Fig. 12.03 The loose fit of a .016 HANT wire in the .022 slot allows minor vertical settling in the final stages of treatment.

The .014 stainless steel wire

If minor arch wire bends are needed for tooth alignment, the .014 steel arch wire is ideal, made to the customized arch form. Elastic chains can be added to the archwire if small spaces are present. If this is done, light forces should be used and 'molar offsets' are needed to prevent mesial rotation of molars (Fig. 12.07).

The .019 / .025 stainless steel wire

If it is expected that settling will take more than two weeks, it is recommended to remain in the .0195 / .025 steel wire until two weeks from appliance removal. This will allow for good control of tooth positions and avoid lower arch collapse, which can occur if a light wire is left in place too long, especially when triangular elastics may be needed. Two weeks before appliance removal the .016 HANT wire can be placed. During this period, and with this wire, some vertical tooth settling occurs (Fig. 12.03). The upper and lower arch forms are also allowed to adjust a little if needed, to restore the balance between the tongue and oral musculature.

Frequent upper arch options

The .014 stainless steel 2 x 2 sectional wire

This light wire is the most frequent option used in the upper arch (Figs. 12.04 & 12.05). It maintains incisor alignment, while allowing the canines and posterior teeth to settle into position. Triangular elastics may or may not be needed at this time in the incisor, canine, or posterior areas. A settling time of one to two weeks is also preferred with this option. This wire should be shaped ideally to avoid flaring of lateral incisors or other unwanted movements. Rectangular stainless steel wire should not be used as an incisor sectional at this time, because there will be the potential for unwanted torque movements.

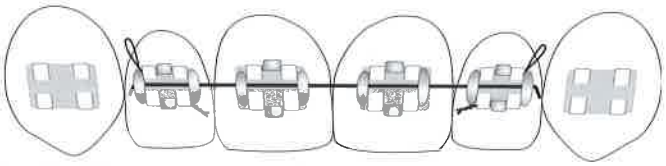

Fig. 12.04 The .014 stainless steel 2 x 2 sectional wire.

Fig. 12.05 The .014 stainless steel 2 x 2 sectional wire is the most frequent option used in the upper arch. Often Kobyashi ties are added for the upper lateral incisor brackets, either mesially or distally, depending on the needs of the case.

The .014 upper steel 3 x 3 sectional wire

If the anterior segments are in an ideal position, then a .014 steel sectional wire can be extended to the canines to maintain alignment (Fig 12.06). Also, if a persistent space has been present in the upper anterior segment, anterior teeth should be lightly tied together. More stability is achieved if a 3x3 sectional wire is used, instead of the 2x2 sectional wire in this situation.

Fig. 12.06 A second premolar extraction case with the anterior segments in an ideal position. The .014 steel sectional wire was extended to the canines, and the extraction site was lightly tied to hold the space closed.

The full .014 steel upper wire

If any detailing bends are needed in the upper arch, or when minor spaces need to be closed or held in a closed position, the .014 steel full wire is helpful in accomplishing the minor tooth movements that are required. However, a full .014 stainless steel upper wire inhibits the settling between the upper and lower teeth, because there is less freedom of vertical movement of individual teeth. In some Class II treatments, where overjet relapse may occur during settling, a full .014 upper archwire will be needed, bent back behind the molars. This tends to slow the settling, but it is required to hold the corrected overjet.
In the same way, a full .014 wire may be needed in the lower arch in some Class III cases during settling. If there is a need for detailing bends, this is normally due to incorrect bracket positioning, but it can also be due to variations between the prescription of the appliance and the anatomy of teeth. If many cases require in/out detailing bends, it may be because the in-out accuracy of the bracket system is not correct. Accurate bracket positioning at the beginning of treatment and repositioning of brackets when needed during treatment is the most effective way to reduce treatment time and improve the quality of treatment results. Hence, bracket positioning remains the single most important mechanical procedure in orthodontics.

As with the lower arch, if minor spaces need to be closed or held closed with an elastomeric chain in the upper arch, it is important to place molar offsets in the arch wire to prevent mesial rotations, due to the small size of the wire and the elastic force (Fig. 12.07). The elastomeric chain is normally ended at the first molars, so second molar offsets are not needed in most cases.

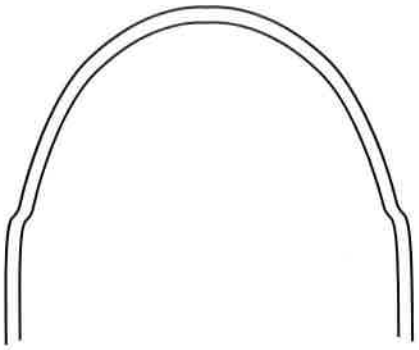

Fig. 12.07 First molar offsets are recommended to prevent mesial rotation of molars when light elastic chains are used with .014 steel wires.

A removable upper appliance during settling

If the maxilla has been widened during treatment, and there is a possibility of transverse relapse, a palatal plate can be used to maintain maxillary width as the case settles (B3 p. 295). Retention is by two .018 steel segmental wires per side inter-proximally between the upper premolars and the second premolars and first molars (Fig 12.08). This avoids the need for ball clasps for retention. Any wires which cross the occlusion tend to interfere with the settling of teeth.

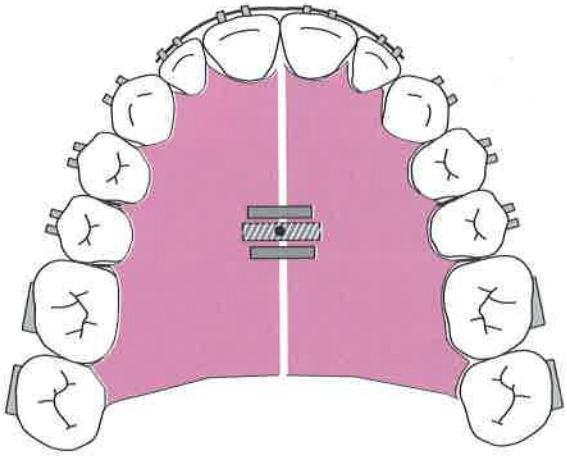

Fig. 12.08 A removable palatal plate can be used to maintain maxillary width during settling. There is a .018 retention wire mesial and distal to each second premolar. See also Case AL in this chapter (page 242).

The mechanics of settling

Time is a factor during the closing stages of treatment. Ahead of the settling stage, some cases merely require retying for two or three visits to allow the rectangular working wires to express themselves (B3 chapter 10).

Some patients have atypical tooth anatomy. Minor wire bending will be needed to manage any variation in the shape and size of the patient's teeth, compared with the average measurements used for the preadjusted appliance. There is a need for the orthodontist to spend time identifying what is required during settling. It can be helpful to have a check-list [2] or an established protocol for horizontal, vertical, transverse and dynamic considerations (Ref B1 p. 207 - 233 and B3 p.279 - 296). The efficiency of the mechanics and the quality of the new generation of milled brackets take most cases to a very good outcome, so tooth positioners (page 259) are used less than previously. However, they remain a useful and effective option in some cases [3]. Patients like to bite where the teeth fit best, and condyle position needs to be checked, because a few patients will posture the mandible slightly, late in treatment (Fig 12.09A).

Avoiding unwanted rotations during settling

Late in treatment, bendbacks are normally required with full .014 stainless steel wires [4] for patient comfort and to prevent spaces from opening. However, the 'bending in' of the end of the wire should be positive but gentle. If over tightened, there can be a rotational effect on the molars, even if there is no elastomeric chain in place (Fig. 12.09B).

In the same way, when four links of an elastic chain are used to close minor anterior spaces, or to prevent spaces from opening, care is needed to avoid lateral incisor rotations. The chain should be light and pre-stretched (Fig. 12.09C) and it is helpful to place extra modules on the distal wings of the lateral incisor brackets (Figs. 12.26 & 12.27) or to tie the brackets with a ligature wire before placing the chain. Extraction sites are normally laced passively to prevent spaces from reopening (Figs. 12.06 & 12.37). If the lacing is too tight teeth may rotate towards the extraction site.

The light up-and-down elastics need to be correctly applied to avoid the risk of rotations (Figs. 12.16 & 12.37). They are typically used for a week full time and then one week at night only. Prolonged use can cause rolling in of the molars and premolars.

Light up-and-down elastics can be hooked on to the tie-wing area of brackets, if there is no archwire present. However, if there is an archwire in place, and the bracket does not have a hook, there will be insufficient space for an up-and-down elastic and a Kobyashi tie will be needed (Fig. 12.49). Kobyashi ties are available as .012 and .014 versions. The smaller .012 size is easier to work with, and after placement it can be stabilized with one or two modules (Fig. 12.25).

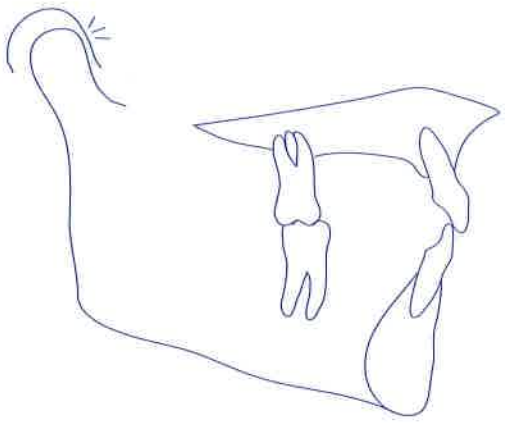

Fig. 12.09 Part A The condyle position needs to be checked clinically during settling, looking for any mandibular displacements.

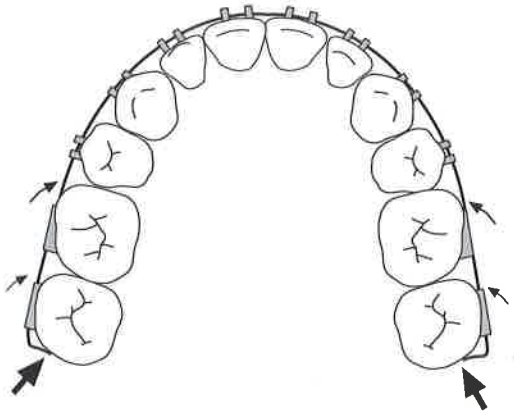

Fig. 12.09B With .014 steel wires bendbacks should be positive but gentle, to avoid the risk of molar rotations.

Fig. 12.09C Elastomeric chain should be light and pre-stretched or 'worked' before placing, to ensure gentle forces are applied during settling with light wires.

Many of the tooth movements are minor during settling, and it is not easy to show these in a text book. However, in the following pages, examples have been selected to show some of the options listed above, along with Case SZ in chapter 2 (page 74).

Treatment sequence AH

A female patient with a slight Class II malocclusion and mild anterior crowding. The case was treated on a non-extraction basis using esthetic brackets.

Fig. 12.10

The case with working steel .019 / .025 wires in place, and passive tiebacks in all quadrants. The incisor relationship, and the buccal occlusion on the right side have been slightly overcorrected.

Fig. 12.13

A lower .016 HANT wire was placed in the lower, with a sectional .014 steel wire 2 X 2 for the upper incisors. Up and down 4 ounce quarter inch elastics were used for one week full time to settle the buccal occlusion, followed by one week of night wear and then appliance removal. Care was taken to avoid too much use of up and down elastics, as this case has a slightly less than ideal anterior overbite. In these cases consideration can be given to a mild IPR among the lower incisors, if there is a need for more overbite as the case goes into retention.

Fig. 12.16

The case after appliance removal and placement of retainers. The short period of settling produced a good improvement in the buccal occlusion, and the outcome is pleasing.

Fig. 12.19

Fig. 12.11

Fig. 12.12

Fig. 12.14

Fig. 12.15

Fig. 12.17

Fig. 12.18

Fig. 12.20

Fig. 12.21

Treatment sequence NE

A female patient with a slight Class II malocclusion, mild anterior crowding, and a slightly deep overbite. The case was treated on a non-extraction basis.

Fig. 12.22

In this case the lower arch required a longer period of settling than the upper. Accordingly, at the start of settling a normal lower steel .019 / .025 wire was kept in place, with active tiebacks. A sectional .014 round steel wire was used in the upper arch, with Kobyashi ties on the upper lateral incisors (Figs. 12.25, 12.26 & 12.27). Up and down elastics are typically used for a week full time and then one week at night only. This avoids the prolonged use, which can cause rolling in of the molars and premolars.

Fig. 12.25

The case then followed the same settling procedures as the previous case, and is seen here shortly before appliance removal. It is good protocol to routinely take dental photos at the end of active treatment, to create a record of the occlusion which has been achieved. These images can be stored and retrieved later if there are retention issues, or if there is any subsequent discussion about what was accomplished during treatment.

Fig. 12.28

The case at the end of active treatment after appliance removal and the placement of retainers. A pleasing improvement in the buccal occlusion was achieved during settling, particularly on the left side.

Fig. 12.31

Fig. 12.23

Fig. 12.24

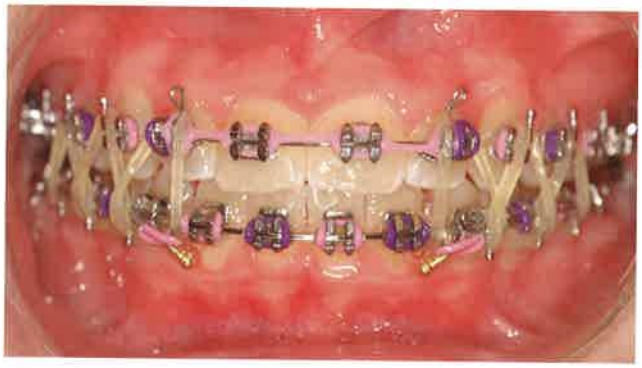

Fig. 12.26

Fig. 12.27

Fig. 12.29

Fig. 12.30

Fig. 12.32

Fig. 12.33

Treatment sequence LA

A female patient with a Class I malocclusion and moderate crowding. The case was treated with the extraction of all second premolars and using metal brackets.

As with the previous case, the lower arch required a longer period of settling than the upper, and the working steel .019 / .025 wire remained in place, with a light elastomeric chain to maintain space closure. The extraction sites were held closed with lightly tied ligatures, and conventional up and down elastics were used to settle the buccal occlusion. A sectional .014 steel wire 2 X 2 was used for the upper incisors, with Kobyashi ties on the lateral incisors.

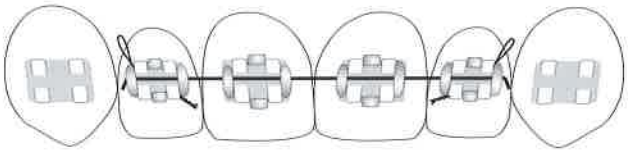

Fig. 12.37A A diagram of the sectional .014 steel wire 2 X 2 as used during settling of this case.

A tooth size discrepancy was noted in this case, with the upper incisors being slightly large compared with the lowers. Some IPR was needed among the upper incisors to allow correction of the small overjet.

The patient showed less than ideal tooth brushing during treatment, and this contributed to the gingival overgrowth (Figs. 12.40, 12.41 & 12.42). However, there was rapid improvement after appliance removal and a period of proper plaque control (Figs. 12.43, 12.44 & 12.45).

The case after appliance removal and placement of retainers. The large upper lateral incisors are evident, and these contributed to the Bolton discrepancy, but the result is pleasing after the extraction of second premolars and appropriate treatment.

Fig. 12.34

Fig. 12.37B

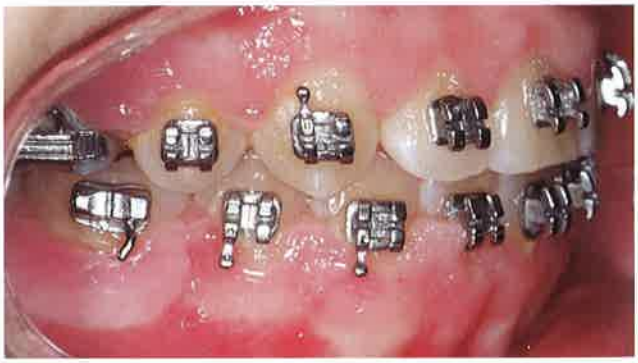

Fig. 12.40

Fig. 12.43

Fig. 12.35

Fig. 12.36

Fig. 12.38

Fig. 12.39

Fig. 12.41

Fig. 12.42

Fig. 12.44

Fig. 12.45

Treatment sequence AL

A male patient with a severe, overclosed Class III malocclusion. There was little crowding, and the case required maxillary surgery with expansion, advancement and down fracture. This rotated the mandible down and back to a satisfactory position.

Fig. 12.46

During settling the lower arch carried a .016 HANT wire to allow the lower arch form to settle. There were firm (but not excessively tight) bend backs, to prevent spaces opening and for patient comfort. The esthetic brackets did not have hooks, so Kobyashi ties were added to lower brackets for the up and down elastics. Kobyashi ties were not needed in the upper, as there was no buccal archwire.

If extraction sites are present they can be held closed with lightly tied figure 8 ligatures. Conventional up and down elastics can be used to settle the occlusion. There was a sectional .014 steel wire for the upper incisors, with Kobyashi ties on the upper lateral incisors. Up and down 4 ounce quarter inch elastics were used for one week full time to settle the buccal occlusion, followed by one week of night wear and then appliance removal.

An upper removable appliance was used (Figs. 12.52A & 12.52B) during the settling stage, to prevent narrowing of the maxillary arch. It has a .018 retention wire mesial and distal to each second premolar.

Fig. 12.49

The case after appliance removal and placement of retainers. When setting up cases like this it can be helpful to switch left and right lower canine brackets, as discussed in chapter five (page 59).

Fig. 12.53

Fig. 12.47

Fig. 12.48

Fig. 12.50

Fig. 12.51

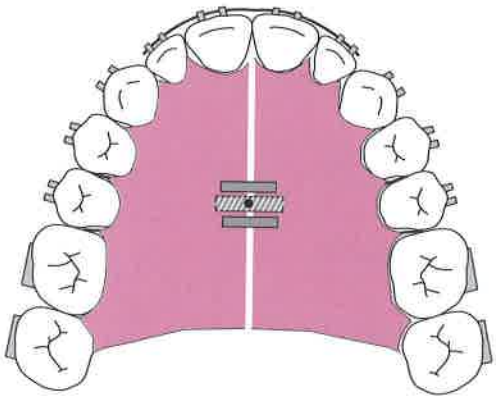

Fig. 12.52A

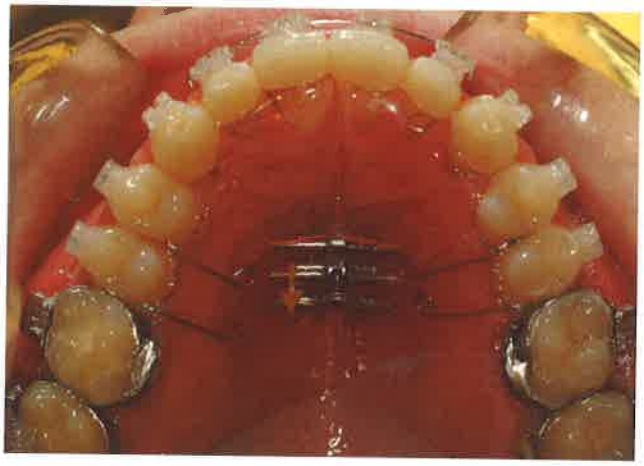

Fig. 12.52B

Fig. 12.54

Fig. 12.55

PREVIOUS BOOKS

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CHAPTER 13

Appliance removal and retainer placement

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Appliance removal and retention

After achieving an ideal result, good retention is needed. This requires patient cooperation and the correct retention procedures. Any post treatment change will be a cause for patient disappointment, and the extra visits will reduce practice efficiency, as discussed in the next chapter. Orthodontists will have their own ideas about retention, but whatever methods are used, an organized and systematic approach is recommended (B3 ch. 11).

The appointment before appliance removal

After case settling is complete, and all spaces have been closed, appliance removal can be scheduled for the next appointment, and this should not be too far ahead. The appliances need to be adjusted to prevent unwanted changes in the meantime, because it will be a disappointment if they are not removed on time. For example, a well known risk is the opening of a minor anterior space, and this can be prevented with a very light continuous elastomeric chain or by a continuous wire tie.

Most cases will need a lower bonded retainer, and impressions for these should be taken at the appointment before appliance removal. At this visit it is also advisable to thoroughly clean and polish the lingual aspects of any teeth which will have a bonded retainer (Figs 13.15 & 13.16). In this way, minimal cleaning of these areas will be needed at the appliance removal visit, lessening the risk of fluid release from gingival tissues during retainer placement, which weakens the bonding.

The patient should be advised to delay seeing the family dentist until after the first retainer check, unless there are clear caries concerns, to allow soft tissues to respond to good tooth brushing. The patient should understand that not all bonding material may be removed, and the first retention appointment will be used for this and to check the retainers. At this visit the teeth can be checked with a black light (Fig. 13.13) and any remaining adhesive can easily be removed.

Removal of the fixed appliances

The day of appliance removal is important for the patient. It is a busy and complex appointment, and should be managed in a consistent and systematic way, with the orthodontist and staff members being fully prepared. Enough time should be allowed for unhurried and thorough procedures, and many practices prefer these long appointments to be in the mornings. Careful removal of appliances, cleaning of adhesive and cement, and placement of retainers needs to be accomplished. Instructions about the retention protocol should be provided.

Early removal of appliances

Occasionally, it is decided to remove appliances after a good improvement has been achieved, but before treatment has been completed. In this situation, the patient (or parent, if the patient is a minor) should be asked to sign two copies of a release statement, acknowledging early appliance removal. These should also be signed by the orthodontist and dated, and examples of suitably worded release documents are available from the AAO and other professional associations.

Complete appliance removal

It is normally preferable to remove all appliances at one visit, as it is more convenient for the patient and efficient for the practice. Intra-oral photos should be taken after wire removal, but when the brackets and tubes are still in place (Fig. 13.01). These are used for future reference and discussion with the patient if any issues arise about retention or instability. A panoramic radiograph can be taken, and a copy sent to the referring dentist, along with a written summary of treatment and areas of concern.

Fig. 13.01 Intra-oral photographs are recommended after the wires have been removed, but when the brackets and tubes are still in place.

Partial or progressive appliance removal

Occasionally, the correction of one arch is completed ahead of the other arch, and there is no need for further inter-arch treatment with inter-maxillary elastics. For example, the upper arch treatment is finished, but there is a need to complete lower incisor alignment. Patients appreciate early appliance removal in one arch, and this often makes them more receptive to continue with single arch alignment.

Progressive appliance removal may also be indicated for adults if bands are used. Band spaces can be difficult to close and keep closed in adult patients, and food impaction can be a common complaint. In this situation, brackets and bands can be removed from the premolars and molars in one or both arches as needed. Bonded tubes can then be placed on the second molars. A full .020 arch wire can be placed, with small molar offsets and slight tip back bends in front of the second molars. A light elastic chain can be used to close band spaces within a few weeks and the remaining appliance can then be removed. Arch wires must be shaped to the patient's arch form during progressive appliance removal, to avoid unwanted changes.

Removal of metal brackets and tubes

Metal brackets can be removed using a dull pair of heavy ligature cutters. Alternatively, a special instrument can be used, remembering these special pliers are not for use with clear brackets. During appliance removal the patient can be asked to bite down on a cotton roll (Fig. 13.02) or soft acrylic wafer to reduce any discomfort from the procedure [1,2].

Removing metal brackets and tubes individually

When removing brackets individually (after taking out the arch wire) it is possible to approach each bracket from a different angle, which can reduce discomfort. However, without an arch wire, there will be an increased risk of a loose bracket in the mouth. With individual bracket removal, the bracket is grasped from either the mesial or distal, beneath the gingival and occlusal wings, parallel to the occlusal plane. A light squeezing motion distorts the base and easily removes the bracket. Most discomfort has been reported in the lower incisor region during bracket removal [1] and torsional forces cause more discomfort than intrusive forces [2]. Bonded molar tubes are removed with a twisting/torquing motion to 'shear' the bracket from the tooth, while the patient bites on a cotton roll or soft acrylic wafer.

Fig. 13.02 During appliance removal the patient can be asked to bite down on a cotton roll to reduce any discomfort from the procedure. Here a special debonding plier is being used, without the archwire in place.

Removing metal appliances with the archwire in place

This avoids the possibility of loose brackets in the mouth and is obviously more efficient, because wires do not need to be removed. If using the debracketing instrument, the brackets can be detached from the tooth surfaces without first taking out the archwires, provided they are held in place with tie wires or modules. If using old ligature cutters, the brackets can be removed whether they are held by tie wires or by elastomeric modules (Fig. 13.03). When removing brackets and wires together in one unit, a twisting/torquing motion is used to detach the brackets from the teeth, which tends to cause a little more discomfort [2].

Fig. 13.03 Removal of metal appliances with the archwire in place is more efficient, because wires do not need to be taken out first, and there is less risk of loose brackets in the mouth. If using old ligature cutters, as here, the brackets can be removed whether they are held by tie wires or by elastomeric modules.

Removing ceramic brackets

Care is needed when removing ceramic brackets, and depending on the manufacturer, there may be specific pliers to be used or removal instructions to be followed. Arch wires need to be taken out first, and it is normally helpful if any excess bonding material is removed from around ceramic brackets, using a high speed flame-finishing bur (Fig. 13.04A & 13.04B).

With Opal CX or CXI ceramic brackets the authors consider two methods of removal:

- The same method as when removing individual metal brackets, using a dull, heavy pair of ligature cutters. (Fig. 13.05). The lift-off plier, and most other pliers designed for the removal of metal brackets, should not be used.
- The method recommended by the manufacturer, which is to gently rotate the bracket with a Weingart plier (Fig. 13.06).

As noted above, it can help patient comfort to firmly bite on a cotton roll for each tooth at the moment of bracket removal, especially if there are slightly mobile teeth, which are more sensitive to appliance removal [1,2].

If a ceramic bracket does not fully detach itself from the tooth surface, the remaining part can be carefully removed using high-speed diamond instruments, copious amounts of water, and high-volume suction.

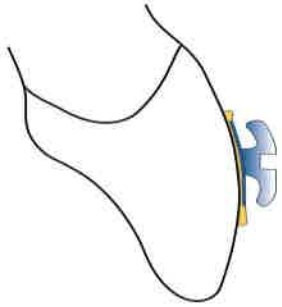

Fig. 13.04A It is normally helpful if any excess bonding material is taken away from around ceramic brackets, before appliance removal.

Fig. 13.04B Before bracket removal, excess bonding material is being taken away from around ceramic brackets, using a high-speed flame-finishing bur.

Fig. 13.05 Removal of ceramic brackets using a dull, heavy pair of ligature cutters.

Fig. 13.06 Removal by gently rotating the bracket with a Weingart plier, according to the manufacturers' instructions.

Band removal

A band removing plier is used to break the adhesive seal. It is generally easier and more comfortable for the patient to use a different point of application for the upper molars compared with the lower molars, because of the contrasting tooth anatomy. When taking off lower molar bands, the tip of the band removing plier is applied to the buccal (Fig. 13.07). Upper molar bands are often more difficult to remove than lowers, and are approached from the palatal side (Fig. 13.08). If attempts at band removal cause too much discomfort for the patient, a small round bur in a handpiece can be used to slit the band, taking great care not to damage the tooth (Fig. 13.09). Band cement is removed using a band cement removing plier and a scaler to check for remaining cement. Finishing burs are sometimes needed.

Fig. 13.07 Removal of a lower molar band by applying the tip of the band removing plier to its buccal side.

Fig. 13.08 Removal of an upper molar band by applying the tip of the band removing plier to the palatal side of the band.

Cases with gingival overgrowth

A few cases have gingival overgrowth at appliance removal (Fig. 13.10) and it should be explained that this makes a full 'cleanup' difficult, particularly in the lower anterior region. It may only be possible to remove the bulk of the bonding material and supply a temporary retainer, bonded or vacuum formed. The patient is then reappointed after two weeks of intensive tooth brushing and flossing. The cleanup can then be completed, and the case can go into normal retention. It is frequently necessary to remake the vacuum formed retainer, as the gingival swelling reduces.

Fig. 13.10 A full 'cleanup' is difficult if there is gingival overgrowth at the time of appliance removal. At a second appointment, a few weeks later, the remaining adhesive can be removed.

Fig. 13.09 In cases where band removal is difficult or uncomfortable for the patient, a high speed band cutting bur can be used to slit the band, taking great care not to damage the tooth.

Removal of cement and bonding material

After appliance removal, the aim is to remove all the adhesive while causing as little damage as possible, and it is particularly important to avoid the loss of any enamel [3]. There are many different burs and techniques for this. However, great care is needed if using band removal pliers or scalers, as there is a risk that such instruments can visibly gouge the enamel, and cleanup procedures with carbide burs only can result in the removal of too much tooth material [3].

For removing the majority of the bracket adhesive, the authors prefer to use a 7901 flame finishing bur at high speed, without water (Fig. 13.11). Multistep rubber polishing kits, with white or green polishing points, can be used for final adhesive removal and polishing (Fig. 13.12). Silicone polishing cones typically contain silicone dioxide or silicone carbide particles in the size range of 6 μm to 40 μm. A water slurry of fine pumice is sometimes preferred, using polishing cups containing aluminum oxide. This produces a glossy enamel surface when it is dry [4]. The Opal Seal bonding agent has a florescent component, and a black light is useful to confirm complete removal of the adhesive (Fig. 13.13).

In cases with extensive white spot lesions (WSLs) there is an increased risk of enamel loss during bracket and adhesive removal. It has been shown that it is helpful to remineralize these lesions with a 1% (w/v) casein phosphopeptide amorphous calcium fluoride phosphate (CPP-ACFP) solution before bracket and adhesive removal [5].

Impressions for retainers

As noted earlier in this chapter, orthodontists have their own ideas about retention, but an organized approach is best. There are many possible protocols, and here are two which the authors find useful.

Method A. At the appointment before the appliance removal visit, an impression of the lower anterior area is taken, so that a lingual retainer wire can be accurately prepared in the laboratory. The teeth which will be bonded are cleaned and polished. In the upper arch, bands or bonded tubes are removed from the upper molars, and an impression is taken. This will be accurate in the posterior area, where good fit of the retainer wire is most critical. Other brackets are removed from the upper model by the lab before construction of the upper retainer. The patient is now ready for appliance removal at the next appointment. A bonded lower retainer (Fig. 13.14) and a wraparound upper retainer (Fig. 13.24) will already be prepared and can be fitted immediately after appliance removal.

Fig. 13.11 Removal of the majority of the bracket adhesive, using a flame finishing bur at high speed, without water.

Fig. 13.12 A white stone or polishing point can be used for final removal of bonding material and then polishing.

Fig. 13.13 If the bonding agent has a florescent component, a black light is useful to confirm complete removal.

Method B. At the appointment before the appliance removal visit, an impression of the lower anterior area is taken, so that a lingual retainer wire can be accurately prepared in the laboratory. The teeth which will be bonded are cleaned and polished. Appliances are removed at the next appointment, and a bonded lower retainer is fitted immediately. An upper impression is taken for a vacuum formed retainer. This can be made in an hour, and fitted on the same day, to be worn only at night. Some patients ask to buy a spare retainer, and this can easily be provided.

Fig. 13.14 The retainer wire should be an accurate fit, and made in the laboratory on a model from an impression taken at the previous appointment.

Fig. 13.15 A case with a 3 to 3 bonded retainer, using a gold plated .019 six strand coaxial wire. Deflection tests show a consistent force displacement on this type of wire.

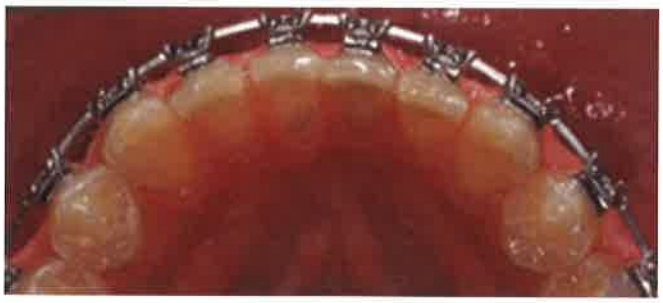

Fig. 13.16 This case is approaching completion. The lingual aspect of incisors often has stain and calculus. The area to be bonded should be cleaned at the appointment before appliance removal.

Bonded retainer technique

Bonded retainers are an essential part of modern orthodontics, and often they are required to stay in place for several years. If they become loose it is inconvenient for the patient and the extra visits reduce the efficiency of the practice.

Accordingly, bonded retainers should be of high quality. An unhurried and thorough technique should be used when placing them, and the following suggestions may be helpful.

An accurate wire. The wire should be an accurate fit, and made in the laboratory on a model from an impression taken at the previous appointment (Fig. 13.14). Care should be taken not to distort it during transfer into the mouth and the bonding process.

The correct wire type. There are differing views on the ideal size of the multi-strand wire. The .015 size is preferred by some orthodontists, and the larger .019 size by others. The images in this chapter show the .019 wire type. Some patients and orthodontists prefer a gold plated wire for esthetics [6].

Enamel preparation. The lingual enamel of incisors has more stain, debris and calculus than the labial enamel, and hence requires more preparation for bonding (Fig. 13.16). The area to be bonded should be thoroughly cleaned at the previous appointment, using a rubber cup with pumice and water, or other appropriate method. At the bonding visit only minimal cleaning will be needed, reducing the risk of fluid contamination from the gingival tissues.

An appropriate bonding agent. A specific bonding agent is used, such as Opal Bond Flow, with the correct viscosity and adhesive capability for bonded retainers.

Precise technique. Care should be taken to ensure proper etching and then bonding in an absolutely dry field, because moisture is known to reduce the strength of the bonding. A cool hair dryer can be useful.

Minimal bonding material. Minimal amounts of bonding agent should be used (Fig 13.15) to ensure patient comfort, and to avoid creating ledges' which can contribute to the wire being dislodged during mastication.

Patient instructions. The patient is advised to have a soft diet for 24 hours and should be given written instructions about retainer care, including the need to return to the practice without delay if there are any problems.

Bonded lingual and palatal retainers

Before treatment the orthodontist will explain the advantages of achieving the treatment goals described in chapter one. Many patients express polite interest in this discussion, but in reality, most are concerned that the treatment will deliver a pleasing smile and good alignment of the upper and lower anterior teeth, sometimes known as the 'social six'.

Bonded lingual and palatal retainers are effective in maintaining this incisor alignment, which is so important to patients. If well constructed, they are more effective than removable types of retainers, and are the preferred option in most cases, as explained below. A recent study in the Netherlands reported 'Most orthodontists placed a bonded retainer in the upper and lower arch, except when the upper arch was expanded during treatment or when extractions were performed in the upper arch, in which case they placed a removable retainer'[7].

Lingual bonded retainers

The classic canine to canine lower bonded retainer, known as a '3 to 3 retainer' (Fig. 13.17) is used by the authors in almost all cases after removal of fixed appliances. There are adequate studies available, as well as consistent experience among orthodontists, that lower incisor crowding after orthodontic treatment is the norm rather than the exception. Reitan's studies [8] showed that the periodontal ligaments need six to eight months to reorganize after tooth movement, and that one year is needed for the elastic supracrestal fibers. Part of this time will have been covered during treatment, if rotations were corrected during early levelling and aligning, but even so, it is logical to recommend and encourage fixed lower retention for our patients. The lower bonded retainer can be extended to become a 5 to 5 retainer in cases where first premolars have been extracted, if there is a particular need to avoid any space opening (Fig. 13.18). If third molars are developing, space of this type is likely to spontaneously close later, but often patients and orthodontists prefer not to rely on this probability.

The normal 3 to 3 bonded retainer can be extended to become a 4 to 4 retainer (Fig. 13.19) after deep bite correction. Any overbite relapse will involve eruption of lower canines and incisors relative to first premolars, and the bonded retainer helps to prevent this. Patients with Class III malocclusions and strong tongue pressure may open lower arch spaces. This seems to occur most commonly between canines and first bicuspids, and a 4 to 4 retainer is useful. Lastly, patients with severe rotation of canines pre-treatment will benefit from a lower 4 to 4 retainer.

Fig. 13.17 The classic canine to canine lower bonded retainer, is used by the authors in almost all cases after removal of fixed appliances.

Fig. 13.18 If there is a particular need to avoid any space opening, the retainer can be extended to become a 5 to 5 retainer in first premolar extraction cases.

Fig. 13.19 The 3 to 3 bonded retainer can be extended to become a 4 to 4 retainer after deep bite correction.

Palatal bonded retainers

The 3 to 3 upper bonded retainer (Fig. 13.20) can be used when there is adequate room for placement, and is effective in maintaining upper anterior alignment, particularly when there is reduced periodontal support in adult cases. It is also useful after treating cases with upper spacing. It is discreet and makes fewer demands on patient compliance than removable retainers, but it requires long-term maintenance. As advised above, care is needed when placing these retainers, because failure rates of up to 47% have been reported, particularly when there is a deep overbite [9,10].

The 3 to 3 upper bonded retainer is used less in younger patients due to overbite and patient care difficulties, but whatever the age of the patient, it is essential to place a local lingual bonded retainer on the central incisors (Fig. 13.21) after closure of a diastema (B2 p. 63).

Labial bonded retainers

The authors have previously suggested the use of labial retainers for the upper anterior teeth (B3 p. 313 & 314). These are convenient and acceptable to younger patients, and should be kept in mind as a useful option in some cases for holding upper incisor alignment for limited periods (Fig. 13.22). It is well known that ectopic upper canines are difficult to retain after correction, and a local labial bonded retainer (B3 p. 314) is recommended, along with a removable vacuum formed type.

With younger patients, after expansion of the palate in the mixed dentition, a palatal bar can be placed and upper incisors can be aligned. After bracket removal, labial bonding of the upper incisors can be used instead of a removable retainer, which avoids the problem of frequent loss of upper removable retainers in young patients. The palatal bar should not be in place for more than three months in Class III cases, to avoid restriction of normal growth and development in a younger patient. However in Class II cases, longer periods of wear are sometimes acceptable.

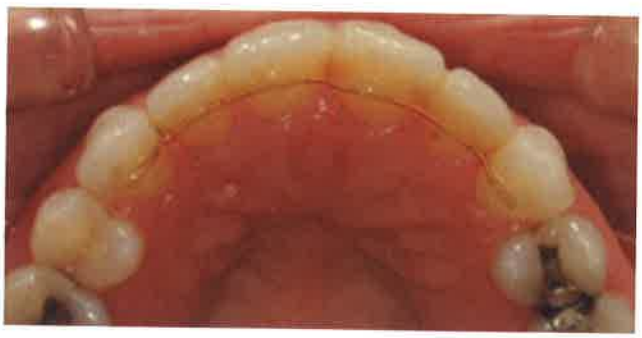

Fig. 13.20 The 3 to 3 upper bonded retainer can be used when there is adequate room for placement, and is effective in maintaining upper anterior alignment. It is used less in younger patients due to overbite and patient care difficulties.

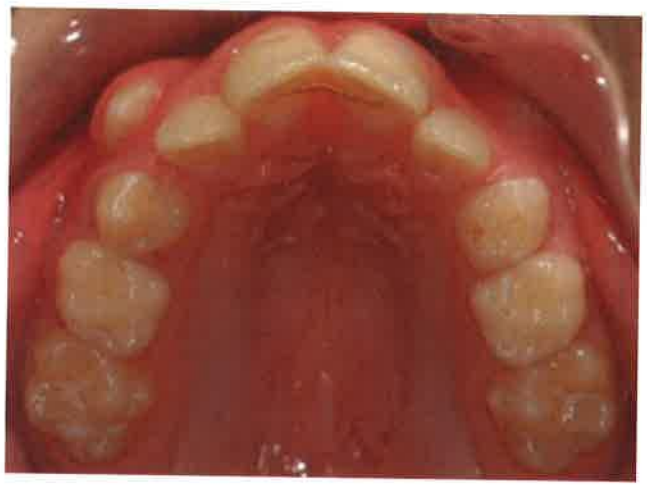

Fig. 13.21 It is essential to place a local lingual bonded retainer on the central incisors after closure of a diastema. In this case there was early closure of a diastema, and the case is about to go into full treatment.

Fig. 13.22 Labial bonded retainers are convenient and acceptable to younger patients for the upper anterior teeth. They should be kept in mind as a useful option in some cases.

Wire and acrylic removable retainers

Over the years there have been many designs for wire and acrylic removable retainers. They are used less than previously, but some orthodontists still prefer them. They are more expensive than vacuum formed retainers, and the wires and acrylic tend to be less accepted by patients.

The traditional Hawley retainer is seldom used by the authors. The labial bow and Adams cribs require regular adjustment, and the design has wires crossing the occlusion, which makes them liable to distortion or breakage and restricts settling.

However, a 'wrap around' wire and acrylic removable retainer can be most useful (Fig. 13.23) and has been previously recommended (B2 p. 308). It allows the posterior segments to settle, and can be used to maintain tight contact points or to close any minor spaces. The labial wire on a Hawley retainer lies between the canine and premolar, and usually interferes with the lower occlusion. A wrap around retainer is preferable for this reason, and settling can continue without retainer interferences on the occlusal surfaces, while the upper posterior transverse dimension is held. The longer the wrap around upper retainer can be used without incisor relapse, the better retention will be, but as noted above, these retainers are not as effective as vacuum formed retainers or bonded fixed retainers at holding upper incisor alignment. Some orthodontists recommend wearing the appliance as much as possible for six months, gradually reducing to night time wear, while others advise night wear only from the time of fitting [11].

Fig. 13.23 The wrap around retainer allows the posterior segments to settle, and can be used to maintain tight contact points or to close any minor spaces.

Vacuum formed removable retainers

This type of retainer is relatively easy, quick and inexpensive to make. It is well accepted by patients, because it is light and transparent, and requires little or no adjustment by the orthodontist. These factors explain why the vacuum formed removable retainer, or VFR, is a popular and widely used form of removable retainer. It is beyond the scope of this book to cover all the details of VFRs, but a few general comments may be made.

Vacuum formed retainers tend to be more effective in the upper arch than in the lower arch, because of the better retention (Fig. 13.24). In patients with inflamed soft tissue at the end of treatment, a vacuum formed lower retainer is often preferable to a bonded retainer. After oral hygiene improves, then a bonded retainer can be placed.

VFRs can be thin and very retentive, or thicker and more robust, but less retentive. This depends on the size of the polyvinyl chloride sheet (normally 1.5 mm) and on the heat applied to it. VFRs are good at retaining anterior alignment, but are less effective in holding corrected rotation of canines or small upper lateral incisors, due to their conical shape.

A randomized controlled trial [12] reported that most patients prefer VFRs to Hawley retainers. There were fewer VFR breakages than in the Hawley group, and VFRs were more cost-effective from all perspectives. Although they are less effective than bonded retainers, VFRs can be adjusted to make minor tooth corrections (chapter 14) or carry elastics during retention, which is an advantage. Lastly, VFRs should be equilibrated to help stabilize the occlusion.

Fig. 13.24 The vacuum formed upper retainer, or VFR, is well accepted by patients, because it is light and transparent, and requires little or no adjustment by the orthodontist. It is tooth borne, as indicated by the arrows, and works best if it is not extended on to the gingival tissue.

'Full time' or 'night-only' retention?

Removable retention can be 'full time' or 'night-only' and there are advantages and disadvantages to both approaches. As with other aspects of retention, orthodontists will have their own ideas about this.

Full-time wear. This has the advantage that the teeth are held in the corrected position for 24 hours per day. However, full-time wear is less convenient for the patient and requires greater cooperation. There is an increased risk of breakage or loss, which can allow tooth movement while repair or a replacement is arranged. Full-time wear of VFRs will restrict settling of the occlusion in cases where this is needed.

Night-only wear. This is an easier regime for the patient. The teeth are only held in the corrected position for approximately 8 hours in each 24 hour period, but with VFRs it has been shown that this is as effective as full time wear. A randomized clinical trial, showed that part-time wear from the outset is adequate to maintain tooth position, arch form, and occlusion [11] indicating that there is no advantage to full time wear. There is less risk of breakage or loss with night-only wear, which is an advantage, and it allows settling of the occlusion during the daytime.

Fig. 13.25 Full-time retainer wear has the advantage that the teeth are held in the corrected position for 24 hours per day, but there is an increased risk of breakage or loss.

Fig. 13.26 Part-time retainer wear, for 8 hours in each 24, is an easier routine for the patients. With VFRs it has been shown that this is as effective as full time wear.

Positioners

In the past, positioners (Fig. 13.27) were often fitted at the completion of orthodontic treatment, to improve settling of the occlusion (B3 p. 311). They are used less than previously, because modern preadjusted appliances produce such high quality results. If it is planned to use a positioner, it is advisable to inform the patient at the start of treatment. This may lead to better cooperation than suggesting one at the end of treatment.

A positioner is a useful option after appliance removal, and should be kept in mind in the following situations:

- For patients who are seeking early removal of the fixed appliances. Good wear of a positioner will produce further improvement.
- A well constructed positioner can have a vertical bite-closing effect after correction of an anterior open bite.
- After use of functional appliances, followed by fixed appliances, a well constructed positioner can have a beneficial A/P effect, holding the mandible in an ideal position [13].

Fig. 13.27 A positioner is a useful option after appliance removal, to improve settling of the occlusion.

Patient letters after appliance removal

Shortly after appliance removal, a post-treatment letter can be mailed or handed to the patient, covering the matters discussed in the post-treatment consultation. It can include some of the following topics:

- Congratulations on the completion of active treatment.
- Restatement of the post-treatment discussion, emphasizing that any retention problems generally occur in the first six months after active treatment, and that special care is needed in this period.
- An assurance that the orthodontist continues to be involved in the retention process, and appointments are available upon request.
- An explanation of the normal schedule for retention appointments, noting that extra appointments can be made for any retention problems.
- Clarification and restatement of future fees for retention visits, as explained at the beginning of treatment.
- Notification of the date when the patient becomes responsible for calling and scheduling retention visits (see chapter 14). This is referred to as 'will call' and generally occurs 18 to 24 months after appliance removal, unless there are retention complications.
- A second follow up letter should be sent at the 'will call' date, to clarify this and other office policies.

Dentist letters after appliance removal

After appliance removal, a letter can also be sent to the referring dentist with the following information:

- A note of appreciation for the referral.
- A short summary of the initial diagnosis and treatment plan, noting any unusual aspects of the case.
- A copy of the final panoramic radiograph, with an explanation of any specific areas of interest.
- A comment on any complications during treatment.
- A note that the patient has been instructed to contact their general dentist for an examination and cleaning.

Fig. 13.28 Post-treatment letters can be prepared for the patient and the referring dentist.

The post-treatment consultation

By the end of treatment, many patients will have forgotten the details of their starting malocclusion, and making time to show them 'before' and 'after' records is beneficial. They are normally very pleased to see the dramatic changes achieved. Some orthodontists prefer this to be a chair side discussion, after appliance removal, while others schedule a more formal appointment in a consultation room.

The post-treatment discussion is a good opportunity to remind the patient of the importance of the retention phase. It is also a time to explain the sequence of practice visits needed during retention, along with the management of lost or broken retainers, and other office policies. A 'Thank you' to the patient for choosing the orthodontist for treatment is often appreciated.

A patient wall

Some practices like to set aside an area on a wall to show photos of smiling patients, after completion of their treatment (Fig 13.29). Although it does take up some space 'the wall ' soon becomes an area of interest, and many patients like the idea. It should be managed with the sensitivity appropriate to the practice values, and obviously with permission of the individual patients.

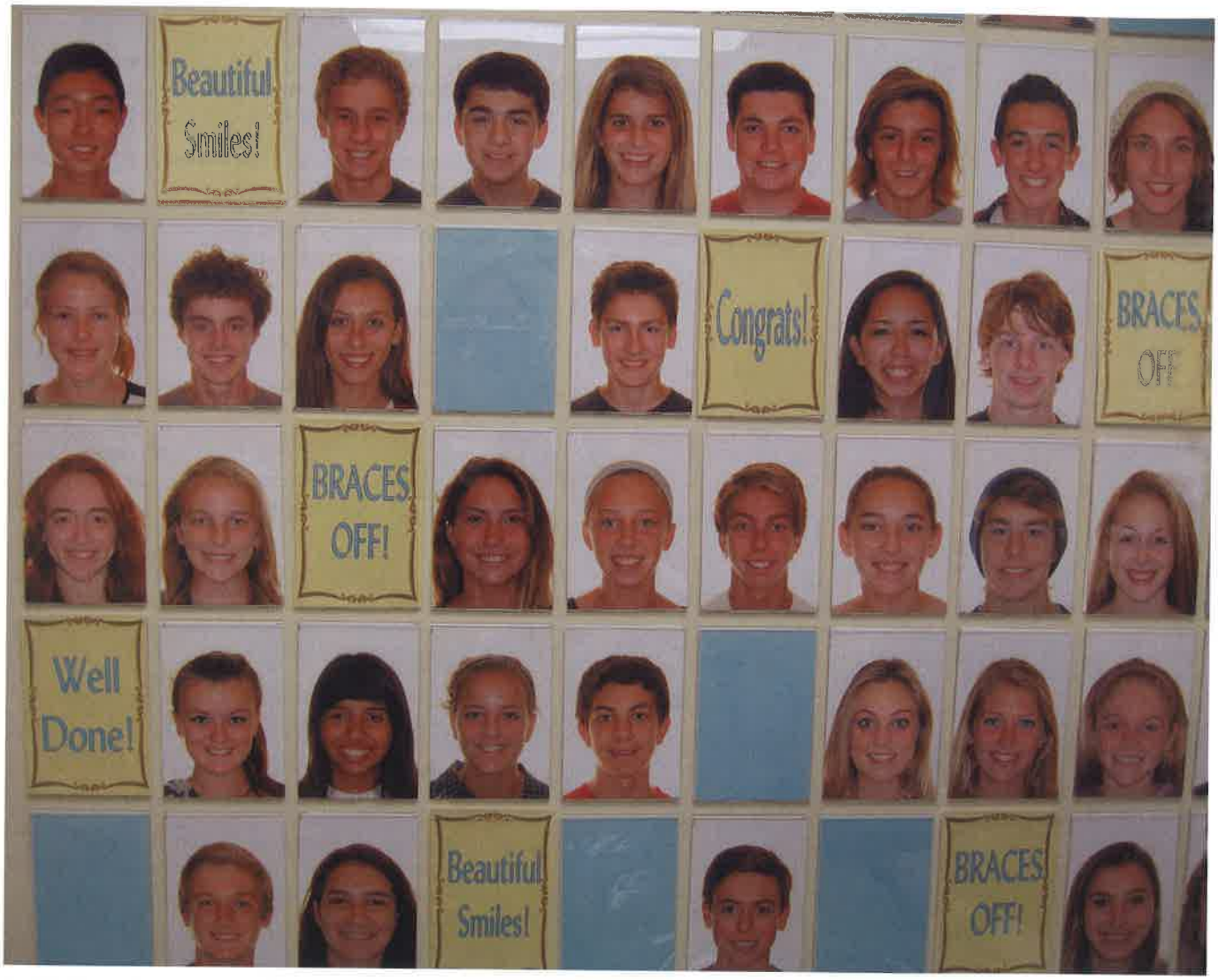

Fig. 13.29 A wall area, showing photos of patients after completion of their treatment.

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CHAPTER 14

Retention, relapse and post treatment change

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Retention, relapse and post treatment change

Almost every patient who has orthodontic treatment will require some type of retention to prevent relapse, but there is a shortage of good science about this aspect of orthodontics. There is not enough research data on retention [1] and there does not seem to be any consistent pattern in the use of retention methods [2]. Retention procedures in the Netherlands were found to be mainly 'experience based' because evidence-based information was not available [3].

This chapter has a clinical basis and an informal style, because there is a lack of science. If there is good research, it is quoted, but otherwise the recommendations are based on the lengthy clinical experience of the authors and the selective use of traditional methods.

Most patients are anxious for active treatment to be completed, and are delighted when the time comes for appliance removal. However, despite the orthodontist's emphasis on the importance of the retention phase, some feel the need for a 'break' and do not fully cooperate during the first six months with retainers. This is the most important period of retention, while the periodontal fibers reorganize, and if there is inadequate retention, it is time when the most change tends to occur [4&5].

As with other aspects of orthodontic care, an organized and systematic approach is needed to minimize relapse, and avoid patient or parent disappointment. This helps practice efficiency, and reduces the need for extra and preventable visits during retention.

Patients have different views about the stability of their tooth alignment. This needs to be taken into account, because many will be unwilling to accept any loss of alignment after orthodontic treatment, and may require permanent fixed or removable retention. Others will take a more relaxed long term view, and be prepared to accept minor changes.

'Relapse' versus 'post treatment change'

After good orthodontic care, retention should be uneventful. However, in some cases changes occur, and the expression 'retention problem' does not make a distinction between 'relapse' and 'post-treatment change'.

Relapse This can be due to (1) the periodontal ligaments, which are attached to gingival tissues or alveolar bone and need to reorganize after tooth movement (2) occlusal factors, such as the reappearance of a deep bite after correction and (3) soft tissue causes, notably the tongue and lips. It is well known that some tooth movements are prone to relapse, such as correction of severe rotations or closure of a diastema. With relapse, the orthodontist needs to restore tooth alignment and occlusion, and then resume retention.

Post treatment change This often involves a fourth factor, which is growth. This can occur after the treatment of adolescent Class III cases, if growth continues, but there are other causes. For example, if there is an onset of degenerative periodontal disease or nail biting after orthodontics, unwanted tooth movements can occur. Likewise, if obesity or mouth breathing develops, an alteration in the size or position of the tongue can cause dental and occlusal changes. These are independent of the earlier orthodontic correction.

> *The term 'relapse' describes the reversal of tooth movements or occlusal changes which were achieved during treatment of the original malocclusion.*

> *The term 'post treatment change' describes unwanted changes to the tooth alignment or the occlusion which are not related to the orthodontic treatment.*

Sometimes it is not clear whether relapse or post treatment change is occurring, or if both are involved. For example, if an increased overjet returns after Class II correction, it may be due to poor cooperation with retention, or continuing Class II growth, or a combination of these two elements.

Post treatment change can be more difficult to manage than relapse. There is a need to recognize what is happening, explain it to the patient, and manage the situation appropriately.

If there is relapse, as defined above, this may be due to the quality of the treatment or the cooperation with retention, which can lead to patient concerns and further discussion.

On the other hand, post treatment changes are like complications which can occur after any medical or dental procedure. It can be explained that they are not related to the treatment provided or to cooperation with retainers. This reduces patient disappointment and the need for lengthy discussions.

Planning for post treatment management

At the pre-treatment discussion, the possibility of relapse and post treatment change should be talked about, and comments written in the patient notes. This prepares the ground for managing any changes which may occur after appliance removal.

When discussing *relapse* the following points can be helpful:

- That teeth tend to relapse to the pre-treatment position after appliance removal, and retainers are essential to prevent this. Most patients will be aware of this.
- Patients need to carry some responsibility for retention, by wearing retainers as instructed, and attending for retention appointments.
- Some features of malocclusions are difficult to retain, including the correction of rotations, closure of a diastema or an open bite, and Class III cases (Figs. 14.01-14.04). The patient needs to be informed of any features of their particular case which will be hard to retain.
- Despite good retention, changes can occur after orthodontics. Human faces, bones and soft tissue all change over time, so why not teeth? If the patient's goal is a lifetime of ideal alignment, they should be aware that indefinite retention may be needed to prevent normal age changes.

When talking about *post treatment change* the following points can be discussed and explained:

- Post treatment changes are often due to growth. If they occur, they are like complications which can occur after any medical procedure, and the orthodontist or the patient are not at fault.
- Some malocclusions are known to be at risk of post treatment change, including open bite cases and Class III treatments in growing individuals (Figs. 14.03 & 14.04). For example, the stability of open bite correction has been shown to be unpredictable, with more than a third of cases returning to more than 3 mm of open bite [6].

When explaining the above issues, comments may be used as follows: 'We expect to fully correct your malocclusion, but part of the open bite may return. It is related to the tongue, which may reassert its influence, despite our best efforts'. 'We hope to fully correct your Class III problem, but if there is late growth of the lower jaw, we may lose part of what we achieve.' 'Your lateral incisors have difficult rotations, and we will need to retain them carefully to avoid relapse.' 'Subtle growth changes can occur throughout life. In later years there can be loss of bone support due to reduced integrity of the periodontal tissues, which can cause tooth movement.'

Fig. 14.01 It is beneficial if rotations can be corrected early in treatment, and slightly overcorrected. Patients should be aware that careful retention is needed.

Fig. 14.02 Patients are sensitive to the reappearance of even a minor diastema. Palatal bonded retainers prevent relapse of this type.

Fig. 14.03 Open bites can be fully corrected in the majority of treatments. It is difficult to retain all the improvement, and partial relapse often occurs.

Fig. 14.04 Post treatment change or relapse may be seen after Class III correction. It is often growth related, and can be difficult to manage.

Mechanics to reduce the risk of relapse

The risk of relapse will be reduced if sound orthodontic principles are followed during active treatment.

It helps stability if overjet and overbite problems can be overcorrected during treatment, and then allowed to reach an ideal position before starting retention (Figs. 14.05 - 14.08).

A similar overcorrection is helpful if upper arch expansion is used to treat transverse discrepancies. Ideally, the existing arch form needs to be maintained in most cases, but there are instances where it may be changed without the risk of relapse (page 86). If possible the treatment should be fully completed before appliances are removed, despite requests from the patient for appliances to be taken off the moment the teeth appear to be straight.

Fig. 14.05

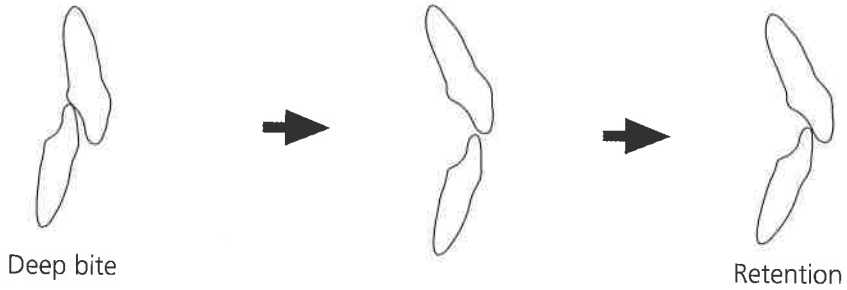


Fig. 14.06

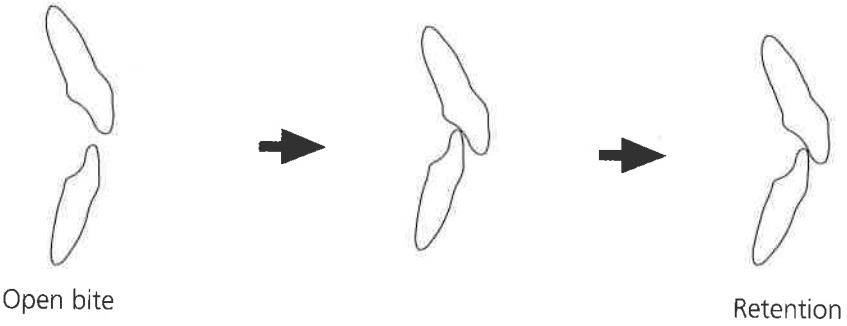


Fig. 14.07

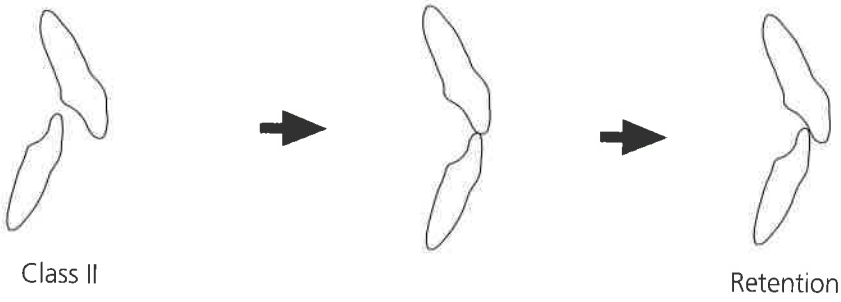
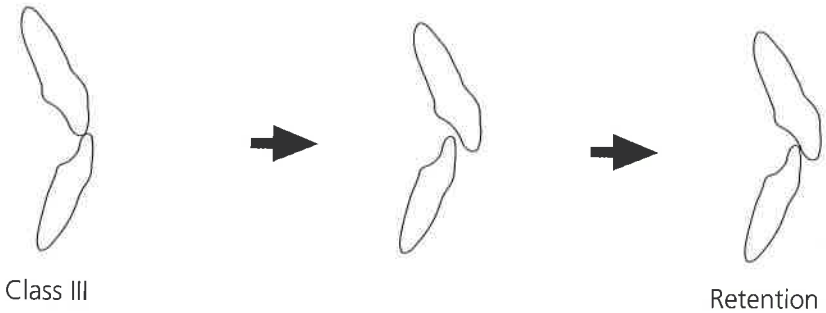


Fig. 14.08



Figs. 14.05 to 14.08 Careful mechanics during active treatment will reduce the risk of relapse. It helps stability if overjet and overbite problems can be overcorrected during treatment, and then allowed to reach ideal values before starting retention.

Overcorrection of rotations is normally beneficial (Fig. 14.11). There are differences of opinion concerning the effectiveness of this, but if there is post-treatment change, the pattern of upper incisor rotations tends to be repeated [7]. Accordingly, reasonable measures should be taken to prevent this, and in most cases the authors try to over-rotate early in treatment (Fig. 14.11). This ensures that there has at least been full correction, and it allows maximum time for the periodontal fibers to reorganize before retention starts [4,5]. Conventional twin brackets are effective for early correction, and then overcorrection, but it can be more difficult with self ligating types (page 45).

Some orthodontists favor supra crestal fiberotomy (pericision) for severe rotations [8,9]. This technique has been described by the authors (B2 p. 145) and is sometimes used by them, but its long term effectiveness may be small [10]. It is technique sensitive, and it is not popular with patients, because it is an uncomfortable procedure, adding additional cost.

The reshaping of triangular crowns avoids black triangles, and can also assist stability [8&9] because it eliminates one point tooth contacts (Fig. 14.12). An upper midline frenectomy should be considered for cases with a large diastema and a grossly enlarged frenum (Fig. 14.09). This has been previously discussed by the authors (B2 p. 59 – 63) and is recommended where needed after space closure. As a rule, the lower arch should not be expanded to treat crowding, because relapse and periodontal complications are seen if arches are over-expanded (Fig. 14.10).

Fig. 14.09 A midline frenectomy can be considered for cases with a large diastema and a grossly enlarged frenum.

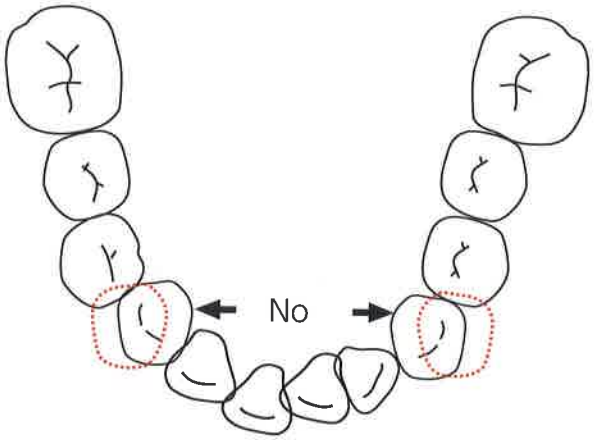


Fig. 14.10 Canine expansion is normally unstable. Relapse and periodontal complications are likely to be seen if arches are over-expanded.

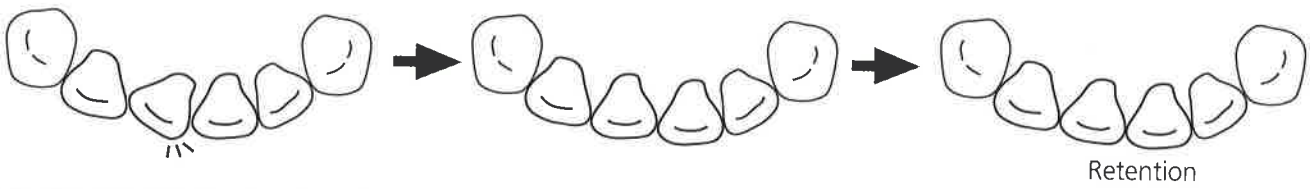


Fig. 14.11 In most cases the authors try to slightly overcorrect rotations early in treatment. This ensures that there has at least been full correction, and it allows maximum time for the periodontal fibers to reorganize before retention starts. Tie wing brackets are generally more effective than self ligating types for early correction, and then overcorrection.

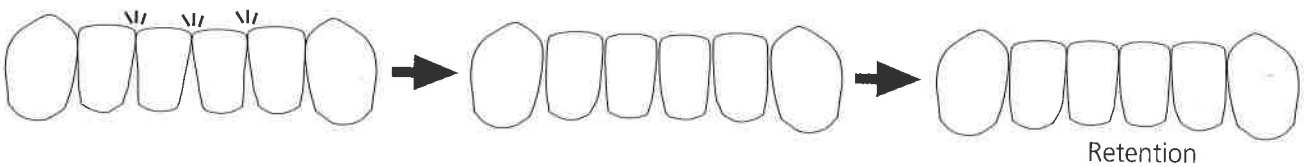


Fig. 14.12 In most treatments the reshaping of triangular crowns is needed to avoid 'black triangles'. Enamel reshaping can also help stability, because it eliminates one point tooth contacts, which are inherently unstable.

Retention protocol

Retention is recommended for almost all orthodontic cases, except a few patients with corrected anterior crossbites, where there is adequate overbite for self retention [11].

> *'Retention is the phase of treatment intended to hold the teeth in their corrected positions after orthodontic tooth movements'.*

Stability needs to be checked, with a protocol for retention visits. If there is minor relapse, simple remedies are usually effective. However, if retention is not monitored for some reason, major changes can occur, requiring fixed appliances for a second time.

The six weekly check. The retention is checked six weeks after appliance removal. Final models and photos can be taken at this visit, if required. The patient should have healthier soft tissues than at appliance removal, and improved settling.

Three-monthly and six-monthly checks. Two or more three-monthly visits are then scheduled, depending on the stability of the case, and these are followed by two or more six-monthly visits. By this time the patient is 18 to 24 months into retention. If the occlusion is stable, the status can change to 'will call' and responsibility passes to the patient to phone and schedule appointments once or twice a year as needed. A letter is sent explaining the policy, and this serves as a formal 'dismissal letter' from regular appointed visits. The patient is reminded that if there are concerns at any time during the retention phase, appointments are available upon request.

An interesting possibility is to set aside two or more morning sessions per year (perhaps on Saturdays) to see retention patients only. A large number of retention patients can be seen with a few staff members. This improves the efficiency of patient care on normal active treatment days.

Focussed retention. Some common aspects of treatment have a known tendency to relapse, such as diastema closure and correction of incisor rotations. It is important to recognize what may be at risk of post-treatment change, and focus the retention accordingly. There have been instances where a canine to canine bonded retainer has been placed in an untreated teenager, with well aligned lower incisors, as a method of preventing almost inevitable late crowding.

Cooperation with retention. To encourage cooperation during retention, particularly in the first six months, written instructions are helpful, and a follow up phone call a week later can also be beneficial.

Maintaining lower incisor alignment

Tooth movement and/or occlusal changes occur after active treatment. They need to be well managed, or there is scope for patient disappointment and extra appointments, which undermine practice efficiency and increase the overhead.

Loss of lower incisor alignment occurs in untreated individuals, as well as in those who have received orthodontic treatment, followed by retention [12]. It is a normal age change, which continues throughout life. Significantly, many orthodontic cases are in retention in the difficult period from 14 to 18 years, when it has been shown that most change occurs in untreated cases [13,14].

Patients should be aware of this.

After orthodontic treatment, the incisors seem to be the most susceptible teeth to relapse. This is unfortunate, because they are normally the teeth which are of most interest to patients. Incisors are exposed to the full list of known relapse factors, and vulnerable to both relapse and post treatment change.

- Periodontal factors. The return of rotations is common.
- Alveolar factors. An increase in inter-canine width or excessive advancing of lower incisors during treatment can lead to post-treatment crowding.
- Soft tissue factors. In Class III cases, lower incisors are frequently retracted, but subsequent tongue pressure can open spaces, typically between the canines and first bicuspids.
- Occlusal and growth factors. Post-treatment growth of the mandible can cause heavier incisor contacts and cause lower incisor crowding.

There is a view [8,9] that minimal or no retention for the lower incisors may be needed provided the starting arch form is maintained (especially inter-cuspid width), incisor contact points are flattened, and fiberotomies are carried out where appropriate. On the other hand, the well known work of Little and coworkers [12,15,16] indicates that permanent retention is needed if tooth alignment is to remain absolutely stable.

Chapter 13 describes the placement of lower bonded retainers. These are the preferred form of retention in most practices, although poor oral hygiene is a commonly mentioned contraindication [3]. They are effective in the majority of non-extraction cases, lower second bicuspid extraction cases, lower incisor extraction cases and the infrequent lower second molar extraction cases.

The authors' view

The authors' experience has been that maintaining the arch form, adjusting contact points, and minimizing lower incisor anterior or posterior movement are all useful factors in reducing the amount of relapse. However, to support these wise precautions, bonded lower anterior retainers are the safest choice to maintain lower incisor stability (Fig. 14.13).

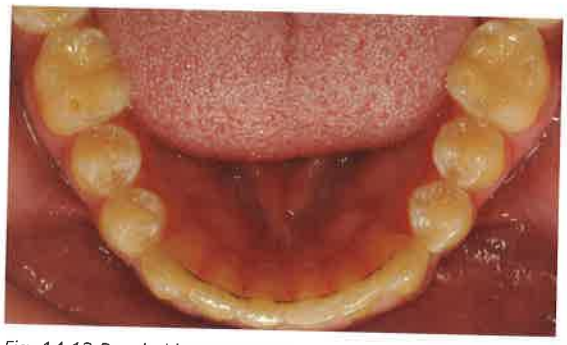


Fig. 14.13 Bonded lower anterior retainers are the safest choice to maintain lower incisor stability.

Lower incisor realignment after relapse

Patients often focus on the alignment of upper and lower incisors, and are quick to point out any irregularity which occurs after treatment. If there has been relapse, as defined above, the orthodontist needs to restore good incisor alignment, and then resume retention. Lower incisor relapse can occur as a result of an inadequate retainer protocol or insufficient cooperation from the patient, and is probably the most common type of relapse seen, but a discussion about blame is not helpful.

There are many methods of realigning lower incisors, and listed below are three options which the authors find useful:

- In many cases it is quickest and easiest to place six or eight lower brackets and quickly realign. This can happen in hours or days.
- In certain difficult cases, after appliance removal, the lower canine to canine bonded retainer can be supplemented with a vacuum formed retainer, worn part time. Some daytime wear may be indicated, especially if a vacuum formed retainer is being used in the upper arch. This reduces the need to wear two vacuum formed retainers at the same time. Later, if a bonded pad loosens on the lower fixed retainer and a rotation occurs, the vacuum formed retainer can be used to correct the rotation over the bonded retainer, and after correction, the wire can be rebonded to the previously rotated tooth. To assure even occlusal contact, the vacuum formed retainer can be placed in hot water for about 15 to 20 seconds and then given to the patient, asking them to occlude firmly. This can be followed by equilibration of the retainer for final fitting to the occlusion.
- The authors have previously described in detail the use of a Barrer retainer [17] also known as a spring retainer (B2 p. 147 and 150). This is an effective device in some cases for achieving quick realignment.

If lower incisor spacing and flaring occurs, as can happen after treatment of some Class III cases, a modified lower wrap around retainer with anterior elastic (5/8 inch 4 oz.) can be placed. The wrap around wire is cut on each side distal to the canines, and modified to form a hook at this position to carry an elastic, labial to the canines and incisors (Fig 14.14). After the incisors have been retracted and spaces closed, a bonded retainer and/or a vacuum formed retainer is used to maintain the corrected position.

Fig. 14.14 A modified lower wrap around retainer can be used to restore good incisor position after lower incisor spacing and flaring.

Recovering lower incisor alignment after post treatment change

Post treatment change is managed differently from simple relapse. There is a need to recognize what is happening, and manage the underlying cause as well as restoring ideal incisor alignment. The patient needs to be well informed.

Two possible situations can be considered as examples:

1. If there is partial reappearance of a deep bite during retention, an increase in lower incisor crowding is likely to occur. If the deeper bite is to be accepted, then some enamel reduction will be required among the lower incisors before using one of the methods described above to realign them. On the other hand, it may be decided to use a bite plane or other method to restore the overbite to normal, in which case incisor realignment will be possible without enamel reduction.

2. If there is late mandibular growth, this can lead to a reduced overbite and lower incisor crowding (Fig. 14.15). Enamel reduction will be required among the lower incisors before attempting to realign them and restore a normal overbite. Efforts to realign lower incisors without enamel reduction will risk a further unfavorable reduction in overbite, or spacing among the upper incisors.

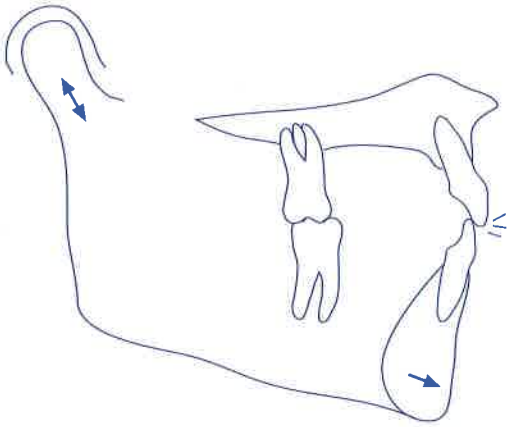


Fig. 14.15 Late mandibular growth is a major factor in post treatment change and relapse. The effects can include a reduced overbite, upper anterior spacing, or a return of lower incisor crowding.

Upper incisor realignment after relapse

When minor relapse occurs in the upper anterior segment, such as rotations, flaring of teeth, or anterior spacing, a vacuum formed retainer with 'resets' can be effective (Fig. 14.16). If the tooth movement is due to minor crowding, interproximal reduction can be carried out before fitting the retainer. As with lower vacuum formed retainers, placing them in hot water for approximately 15 to 20 seconds, followed by firmly occluding with them and then equilibration, is recommended. Any areas where teeth have been reset should not be immersed in the water.

In many cases of minor relapse, particularly if there are rotations, it would be quickest and easiest to place eight or ten upper brackets and quickly realign. This can happen in hours or days, but patients are understandably reluctant to do this. Correcting relapsed rotations with removable appliances is a challenge, because often the relapse was the result of poor cooperation with retention, and the same level of cooperation continues with attempts to realign with removable appliances. A short period with fixed appliances is often the best option.

Recovering upper incisor alignment after post treatment change

As with the lower incisors, post treatment change is managed differently from simple relapse. There is a need to be clear about what is happening, inform the patient, and manage the underlying cause. Attempts to restore ideal incisor alignment without dealing with the underlying cause are unlikely to meet with success. Here are two examples of treatment situations:

1. Upper incisor flaring, with a slight increase in overjet. This can be a post treatment change related to a tongue activity that was either not treated or did not respond to treatment. An upper wrap around retainer can be modified with the facial wires extending only to the distal of the canines, and hooks placed for an anterior elastic. After incisors have retracted, and spacing has closed, a vacuum formed retainer can be placed, with 'resets' if needed, to maintain incisor position.

2. If there is case settling, with an increased overbite, or late mandibular growth, upper anterior spacing may occur due to heavier contact with lower incisors. These changes cannot be corrected as described for minor relapse, and interproximal bonding of upper incisors may be needed to close the spaces. These post treatment changes cause a minor tooth size discrepancy in which the upper anterior segment does not occupy enough space to cover the lower anterior segment with adequate overjet and overbite. Consequently, the treatment of choice is bonding of appropriate surfaces of the upper incisors, such as the distal surfaces of the upper laterals, to increase upper anterior tooth mass. Veneers can be considered if other upper incisor variations are present.

Fig. 14.16 An upper vacuum retainer with a reset to correct the position of the upper right lateral incisor.

Managing a corrected deep overbite

Prevention of bite deepening during retention is best accomplished in the following ways.

In the upper arch, the removable retainer can be modified to act as a retentive 'bite plate'. Anterior acrylic can be added to the retainer and adjusted until the six lower anterior teeth make contact with the acrylic just before the posterior teeth come into occlusion (Fig. 14.17). The bite should not be opened excessively in the posterior areas, to avoid molar extrusion followed by re-intrusion when the retainer is not worn.

In the lower arch, extrusion of anterior teeth can be minimized by extending the bonded lower retainer to include the first premolars, or second premolars in first premolar extraction cases (Fig. 14.18).

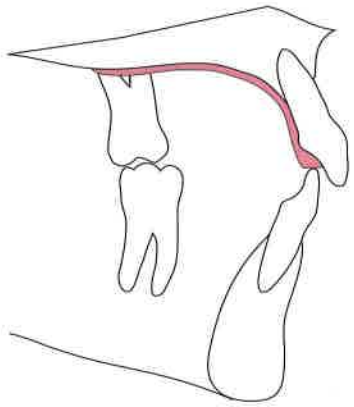


Fig. 14.17 The removable retainer can be modified to act as a retentive 'bite plate' to prevent relapse of a treated deep bite.

Fig. 14.18 After correction of a deep bite, it helps to extend the bonded lower retainer to include the first bicuspids, or second bicuspids in first bicuspid extraction cases.

Managing a corrected open bite

This is a challenge, and it is of prime importance to inform patients about the risk of the open bite returning. It should be emphasized that if an abnormal tongue activity exists, and it is not corrected, then relapse of the open bite is probable, and early referral for myofunctional therapy is recommended. Regrettably, sometimes there is a lack of interest from the patient in correcting the problem, which makes it difficult to achieve and maintain full correction.

The bite can reopen to more than 3 mm of open bite in more than a third of cases [6] and in these instances it is often difficult to determine whether the return of the open bite is relapse or post treatment change, or a combination of the two. Often there is a persistent tongue posturing habit, and/or excessive post-treatment anterior vertical growth change, both of which are hard for the orthodontist to manage.

It is difficult to recommend a good retention method for open bite cases. A frequent protocol is to place a small hole in the palatal acrylic of the upper removable retainer as a 'tongue target' for correct positioning of the tongue, and removal of the acrylic contacting the upper anterior segment can also be helpful (Fig 14.19). The use of a positioner (page 259) to keep the tongue away from the anterior teeth is often a useful possibility, and continued periodic visits to the myofunctional therapist are recommended.

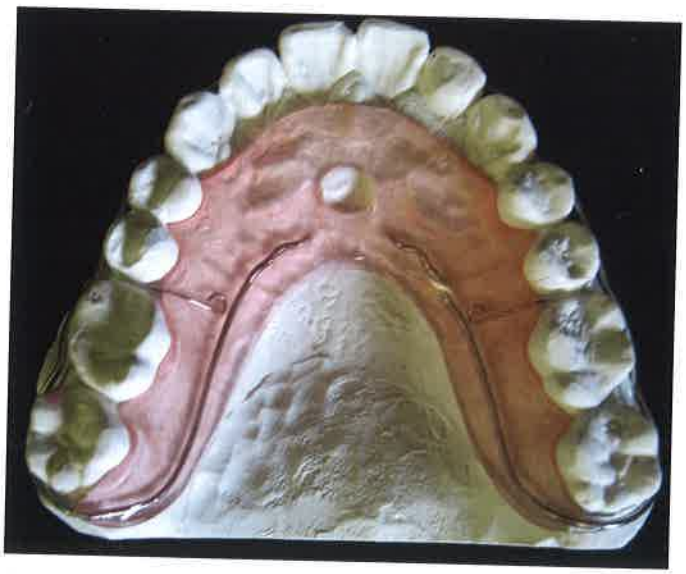


Fig. 14.19 An upper wrap around retainer with a 'tongue target' and acrylic removed behind the upper anterior teeth.

Arch form after active treatment

In the lower arch, research and practical experience has consistently shown that if there is over-expansion, arch form relapse will occur. Without permanent retention, the molars and premolars are going to settle to a position of equilibrium between the facial muscles and the tongue. This was discussed in chapter seven.

In the upper arch there is the same relapse tendency after dento-alveolar over-expansion, unless permanent retention is used. In contrast, the skeletal change from palatal expansion by rapid maxillary expansion (RME), if retained for an adequate time (Fig 14.20), is normally more stable.

Even after diligent care with the arch form, slight amounts of over-expansion can occur. Settling in light wires, as described in chapter twelve, is recommended to guard against later relapse. This allows minor arch changes while the brackets are still in place, so that further adjustment can be made if needed. If arch changes occur after appliance removal, adjustments and correction are more difficult.

If the upper arch is retained with an acrylic retainer and the lower arch is retained with a bonded anterior retainer, the lower arch may narrow in the premolar and molar regions, if it has been over-expanded. However, consistent wear of the upper retainer will hold the upper molars and premolars in the over-expanded position (Fig. 14.21). If this is seen, the upper retainer can be modified or left out completely, while the upper arch settles for two weeks. The upper retainer can then be adjusted posteriorly until it fits the narrower upper arch, or (better) a new retainer can be made.

On the other hand, if the upper arch narrows posteriorly in retention, as can occur after palatal expansion, an acrylic retainer with a mid-palatal screw can be placed to slightly widen the upper arch (Fig. 14.22).

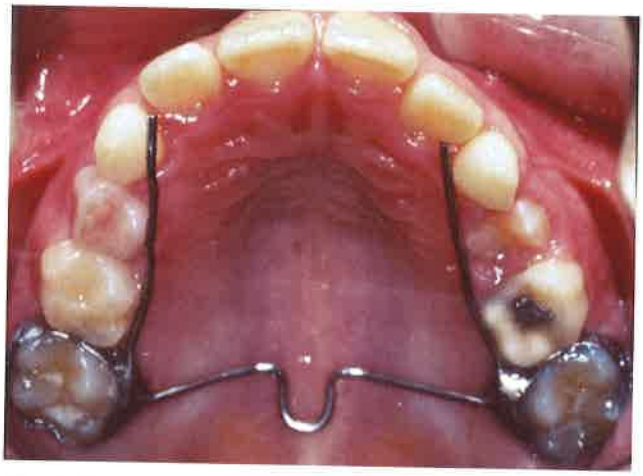


Fig. 14.20 An upper molar holding bar to maintain arch width after rapid maxillary expansion.

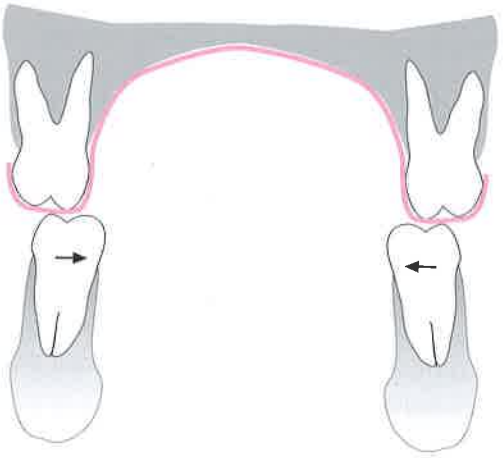


Fig. 14.21 Lower molar and premolar narrowing can occur while the upper arch width is held by a removable retainer.

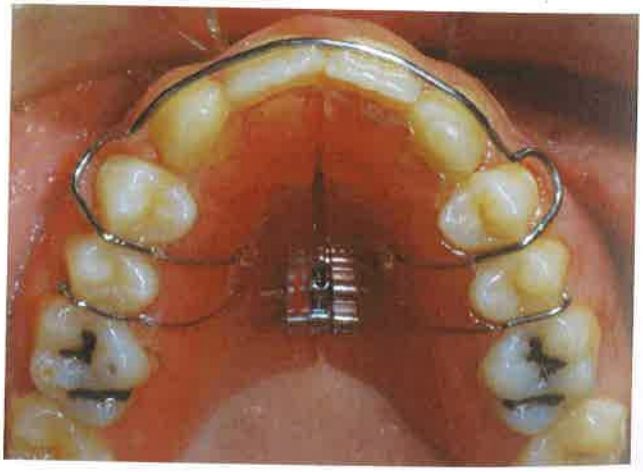


Fig. 14.22 An upper retainer with an expansion screw can be useful if the upper arch narrows during retention.

Managing Class III post treatment change

During the initial consultation patients with a Class III growth pattern should be informed that an unpredictable amount of growth may continue after appliances have been removed. This is not relapse, but post treatment change. If a minimal amount of Class III growth occurs, it can sometimes be treated using vacuum formed retainers with 'attachments' for stability. Buttons are placed on the gingival portion of the upper first molars, slits placed in the lower cuspid areas of the VFR, and Class III elastics attached to the upper and lower retainers (Figs. 14.23 & 14.24).

If the change is more extensive, fixed appliances will need to be replaced. The case is leveled and aligned to rectangular steel wires, and Class III elastics are used for correction. This possibility should be explained to the patient before and after active treatment.

Unfortunately, if post treatment change is extreme, surgical correction may be necessary. In cases where there is a suspicion of further significant Class III growth, it is advisable to delay treatment until one year after the growth spurt has finished.

Fig. 14.23 Post treatment change is sometimes seen after Class III treatment, as in this case.

Fig. 14.24 Class III elastics can be applied between bonded buttons on the upper molars and a well fitting lower vacuum formed retainer. An upper vacuum formed retainer is also worn, to maintain upper alignment. This approach is only suitable to correct mild problems.

Managing Class III relapse

Class III relapse can be due to inappropriate retainer protocol or inadequate cooperation from the patient with retention. If incisor relapse is seen in a treated Class III case, and it is not related to growth or poor retention, it suggests an error in diagnosis. It may be that the planned incisor position (PIP) for the upper incisor (B3 p. 162) was not realistic due to the severity of the skeletal discrepancy, or due to unfavorable growth during active tooth movements.

This is a serious situation. The authors use 120/80 for the limit to incisor torque compensation in Class III treatment, but this is only a guideline, and it differs from case to case (Fig. 14.25). They have previously noted that it is unwise to correct a Class III malocclusion by orthodontics alone, unless a normal overjet can be achieved (B3 p. 230). If incisor relapse is occurring, it may be ineffective to attempt further orthodontics alone to deal with the problem. There will be a risk of periodontal damage or root resorption if a second attempt is made to achieve an ideal incisor relationship in what is probably an orthognathic surgery case. Instead, new records and a revised diagnosis and treatment plan are probably indicated.

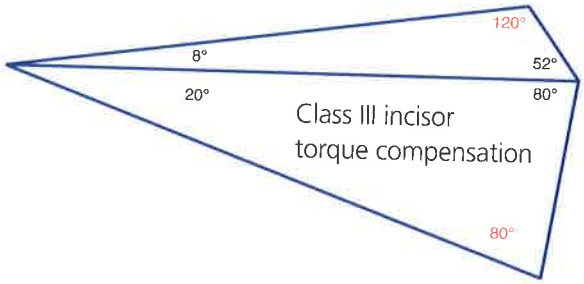


Fig. 14.25 There are limits to incisor torque compensation in Class III treatment. The authors use 120 / 80 as a useful guideline, but the limits differ slightly from case to case.

Managing Class II cases after treatment

If there is partial return of an increased overjet due to relapse, this minor Class II change can be treated in a similar way to minor Class III relapse, using vacuum formed retainers and Class II elastics.

If the return of an increased overjet is due to post treatment change and adverse growth, it can be difficult to manage. For example, condylar changes or excess vertical growth of the maxilla can cause the mandible to rotate backwards, which may require the return to fixed appliances, as well as other forms of Class II correction.

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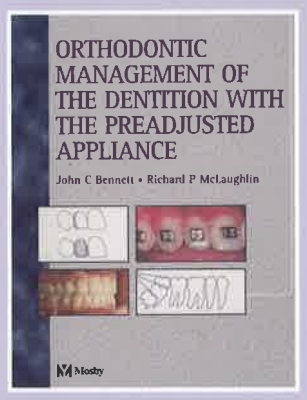
Fundamentals of Orthodontic Treatment Mechanics

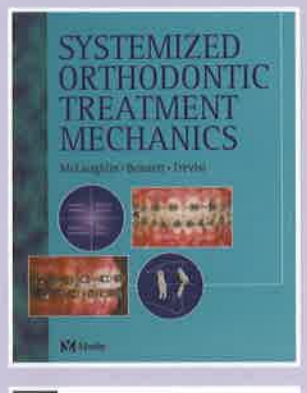
This is the final book in a trilogy by Dr. Bennett and Dr. McLaughlin. It completes the description of their system of orthodontic treatment mechanics, and it is intended to be read with two earlier volumes, published in 1997 and 2003.

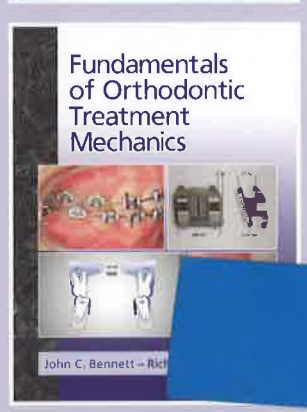
Taken together, the three books describe proven techniques and appliances, and an overall treatment philosophy which has seen widespread acceptance across the world.

The authors bring a lifetime of experience to the subject. Their treatment method has been based on science from the outset, going back as far as the 1980s, and has been refined over the years by treating thousands of cases and by suggestions from colleagues worldwide. In its final form the treatment system is known as 'McLaughlin Bennett System 4.0' and it defines a systemized and structured approach to orthodontic care.

This book brings everything up to date. It describes important recent developments, and at the same time clarifies and updates earlier work, with references to previous texts. There are entirely new chapters on case settling and post-treatment management, which had not been fully explained previously, and new information on bracket design and appliance versatility. Many advances and improvements are explained, backed up with a range of treated cases. This book will be invaluable to orthodontists at all levels who are seeking to provide high quality care. For students, looking for a concise understanding of modern treatment methods, it offers a clear pathway forwards.







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